TEMPERATURE-CONTROLLED POLY(IONIC LIQUID) MICROFLUIDIC VALVES

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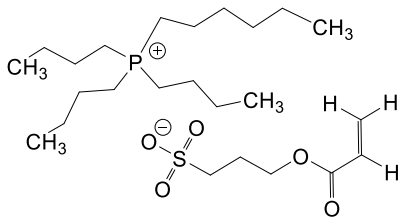
Introduction

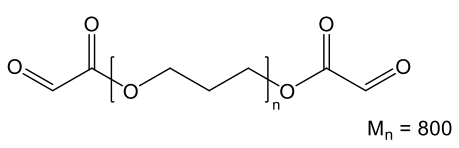
Poly(ionic liquid)s (PILs) are ionic liquids that feature polymerizable groups either in the cation, the anion or both. Applications of these materials include solid ion conductors, CO_2 absorption and energy storage. Furthermore, a branch of PILs feature lower critical solution temperature (LCST) behaviour, making them suitable for the synthesis of temperature responsive materials. The aim of this study was to synthesize thermo-responsive crosslinked PIL hydrogels based on phosphonium PILs and embed them in microfluidic devices to be used as temperature controlled valves.

PIL Hydrogel Synthesis

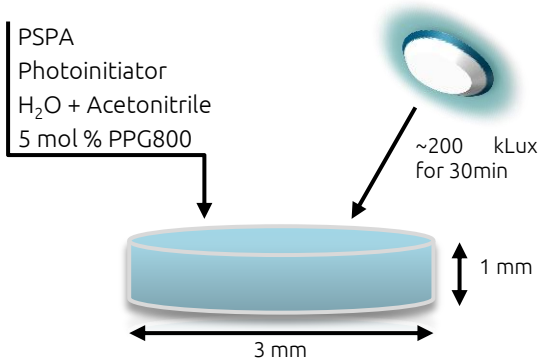


Tributylhexyl phosphonium

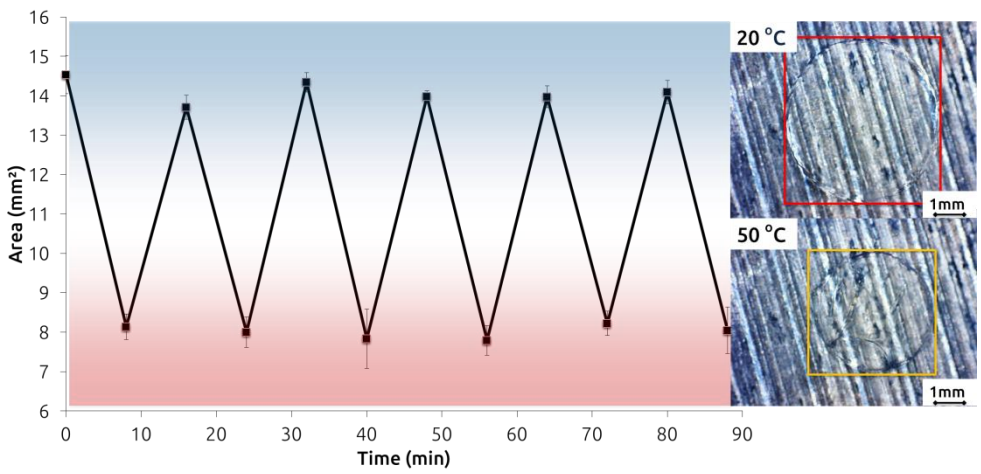
3-sulfopropyl acrylate (PSPA)



Poly(propylene glycol) diacrylate (PPG800)

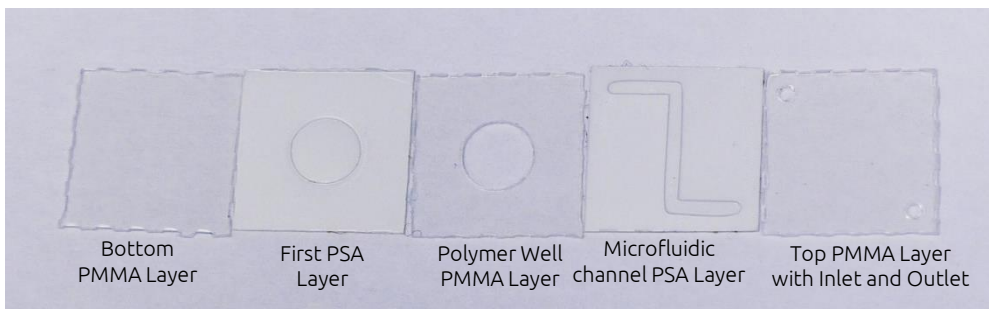


Temperature – Induced Shrinking

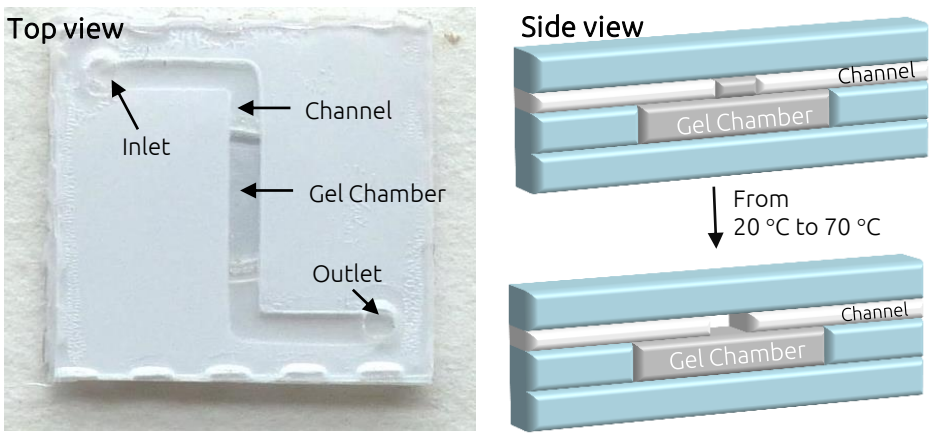


The increase in temperature from 20 °C to 50 °C causes the hydrogels to shrink by ~ 44 % (± 3 %, n = 6) and revert back to ~ 97 % (± 2 %, n = 6) of their original size when the temperature is lowered to 20 °C.

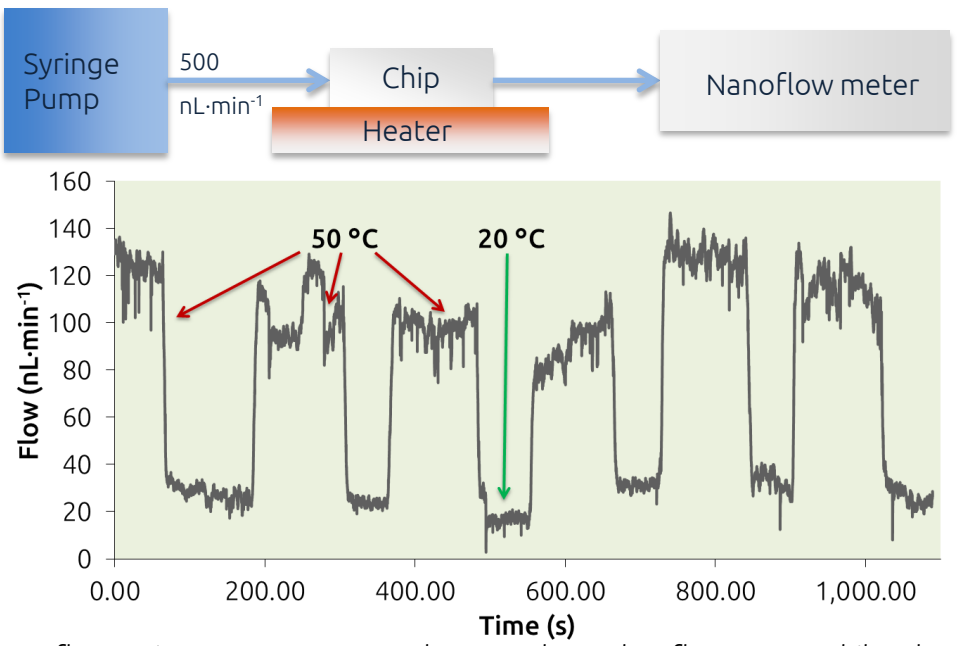
Microfluidic Chip Design



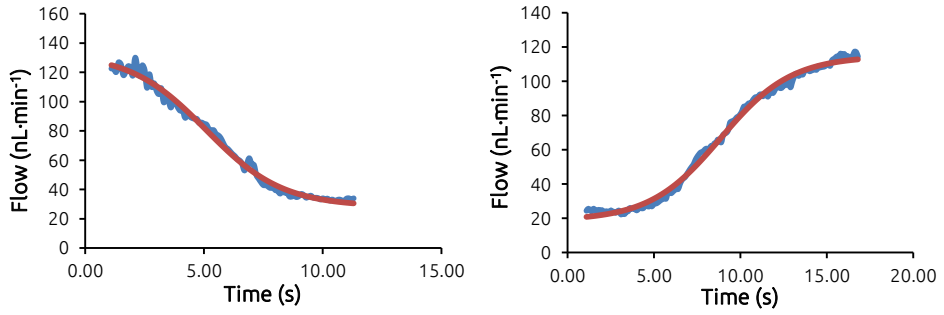
The microfluidic chip consists of three layers of poly(methyl methacrylate) bound with two layers of pressure sensitive adhesive (PSA). The channel was made in the PSA layer (~250 µm). The device has a total thickness of 1 mm.



Flow Characterization



A flow microsensor was used to analyze the flow rate while the temperature was cycled between 20 °C and 50 °C. When the chip was heated to 50 °C, a flow of ~130 nL·min^{-1} was observed, while at 20 °C the flow rate dropped to ~30 nL·min^{-1}.



Opening and closing time for the PILc hydrogel valve vary between 6s to 8s, which are particularly fast times for this type of valves.

Conclusion

PSPA crosslinked hydrogels where synthesized and had their temperature-response quantified. Following this, they were embedded in microfluidic devices as temperature controlled valves. The analysis showed that they can modulate the flow of deionized water through the chip when the temperature was cycled between 20 °C and 50 °C.

Acknowledgements

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