# Tuning the Stimuli-Responsive Properties of Poly(Ionic Liquid)s

Alexandru Tudor, Larisa Florea*, Dermot Diamond

Insight Centre for Data Analytics, National Centre for Sensor Research,
Dublin City University, Dublin, Ireland

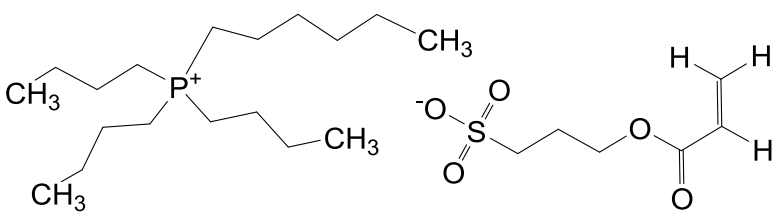
Centre for Data Analytics

Insight

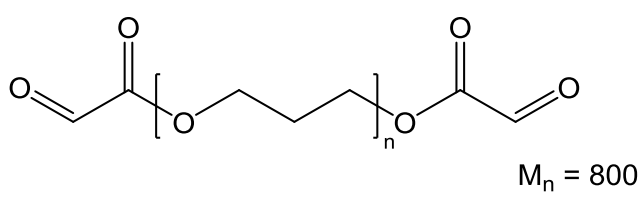
## Introduction

Poly(Ionic Liquid)s (PILs) are a class of ionic liquids that feature polymerizable groups in either the cation, the anion or both. PILs can be used in various applications, including solid ion conductors or for $CO_2$ absorption. Several PILs show the presence of a lower critical solution temperature (LCST), making them suitable precursors for the synthesis of stimuli-responsive materials that have the ability to change their conformation in response to variations in their external environment. The aim of this study was to synthesise crosslinked PIL hydrogels, namely poly(tributylhexyl phosphonium sulfopropyl acrylate) (PSPA) using different crosslinkers, and to characterise their swelling/contracting behaviour under varying temperature and salt solution compositions.

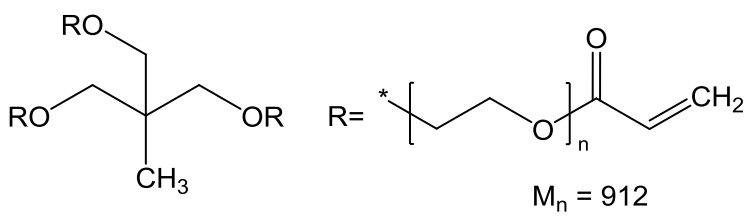
## Molecular Structures



Tributylhexyl phosphonium 3-sulfopropyl acrylate (PSPA)

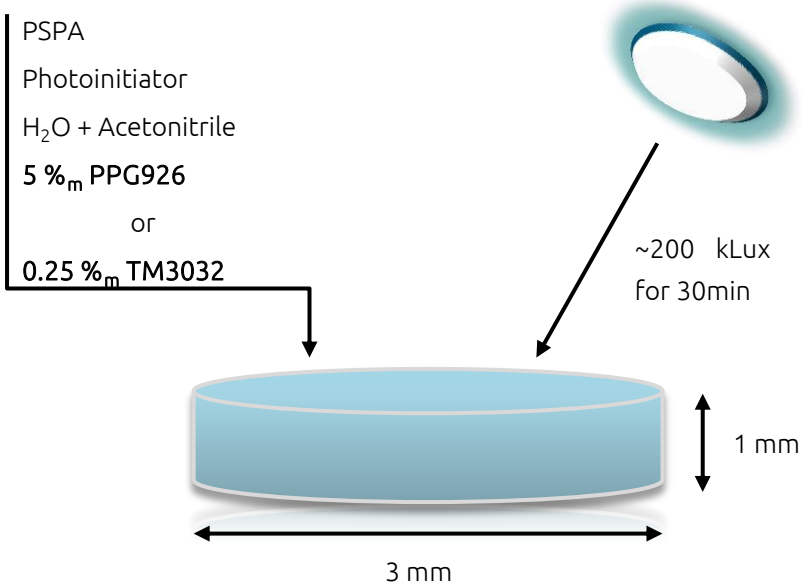



Poly(propylene glycol) diacrylate (PPG926)



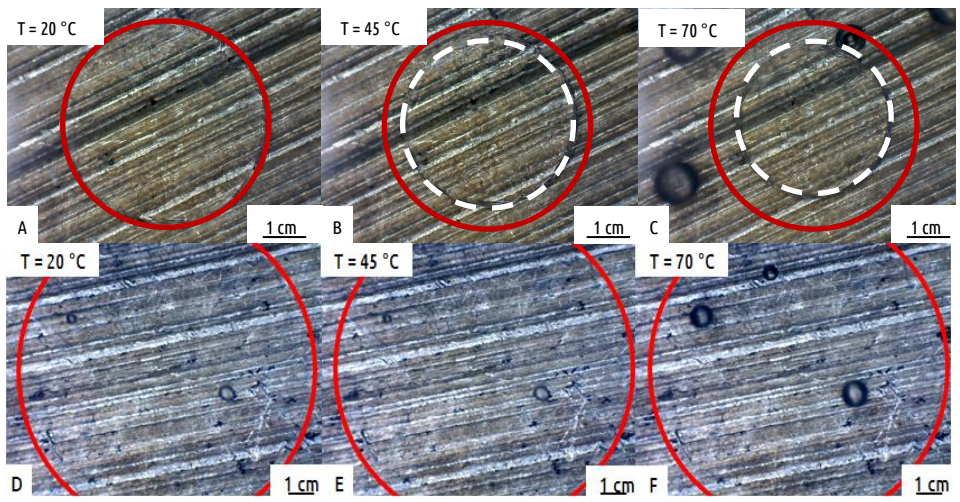

Trimethylolpropane ethoxylate triacrylate (TM3032)

## Experimental Method



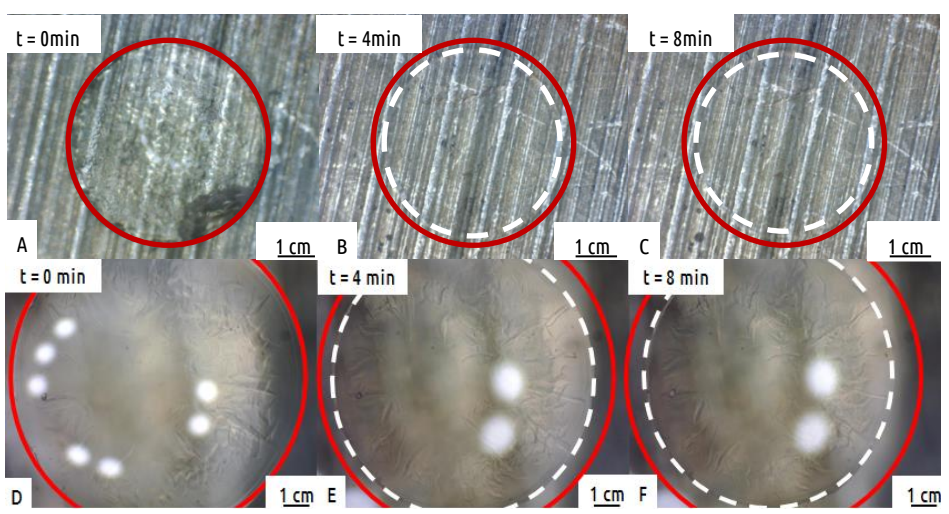

Two different crosslinkers, PPG926 and TM3032, were used to synthesise two different hydrogels, namely PILc926 and PILc 3032, respectively. The thermal response was measured by taking digital microscope images of the hydrogels swollen in deionized water between 20 and 70 °C, in 5 °C steps. The salt response was measured by placing the hydrogels in a 1% w/w NaCl solution and taking images every 1 min for a total duration of 10 min.

## Temperature induced shrinking response




In the case of PILc926, the thermo-response measurements indicated an average area shrinking of the hydrogel of 53.37% ± 12.55% (N=3) when the temperature of the hydration medium was raised from 20 to 70°C (A - C), while in the case of PILc3032 the thermal response was negligible (D – F).

## Salt induced shrinking response




In the case of changing the hydration medium to 1% w/w NaCl solution, the PILc926 hydrogel was also found to contract by 17.13% ± 2.29% (N=3) (A -C), while in the case of the PILc3032 hydrogel an average shrinking of 22.89%±11.02% (N=3) was observed under the same experimental conditions (D - F).

## Conclusion

A series of crosslinked PILs hydrogels were synthesised using different crosslinkers in various concentrations. It was shown that the actuation properties of these PILs hydrogels in response to both temperature and salt solutions can be finely-tuned by varying the type of crosslinker used and its concentration inside the hydrogel network. Based on these properties, the crosslinked PIL hydrogels could be used as thermo-actuated micro-valves or ionic strength modulators in microfluidic devices.

## Acknowledgements

The authors are grateful for financial support from the Marie Curie Initial Training Network funded by the EC FP7 People Programme OrgBIO (Marie Curie ITN, GA607896) and Science Foundation Ireland (SFI) under the Insight Centre for Data Analytics initiative, Grant Number SFI/12/RC/2289.