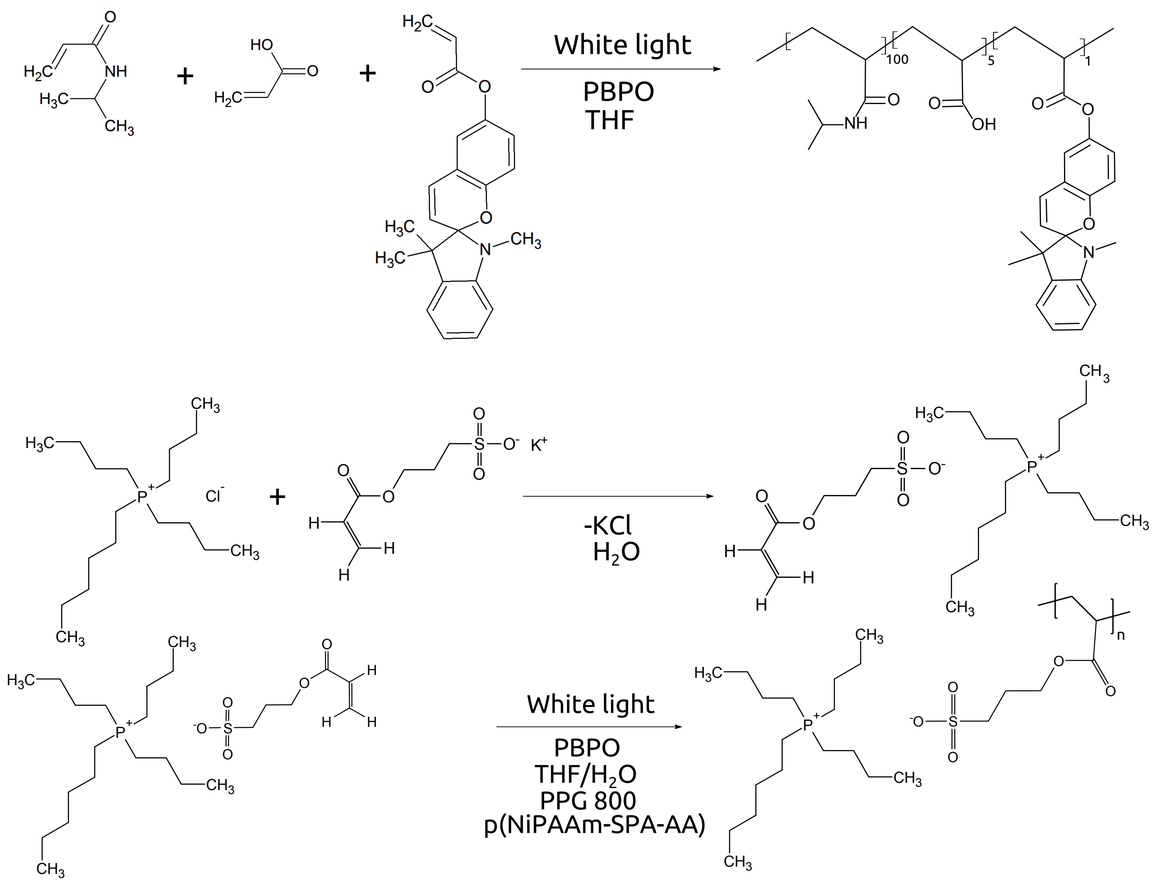
Novel Semi-Interpenetrated Networks Based on Poly (Ionic Liquids) and Dual Responsive Polymers

Alexandru Tudor, Simon Gallagher, Larisa Florea* and Dermot Diamond
Insight Centre for Data Analytics, National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin, Ireland.

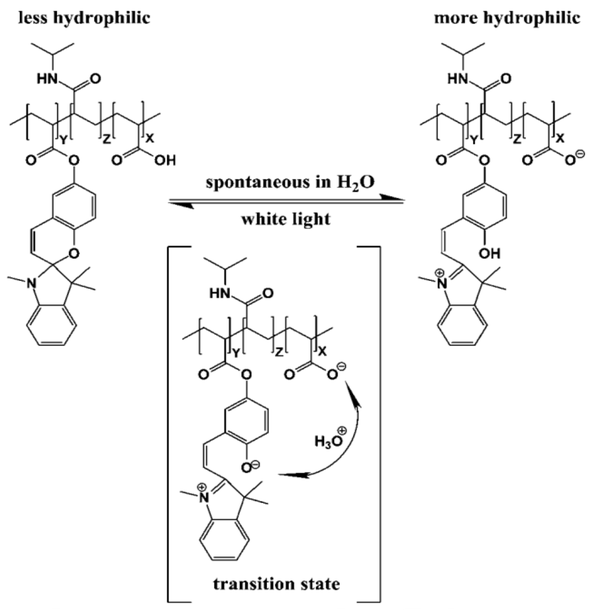
Introduction

Semi-interpenetrating networks (sIPNs) are a type of polymer network in which one polymer is crosslinked in the presence of a linear polymer solution. In this study, several sIPNs have been developed in which the poly(ionic liquid) (PIL) tributylhexyl phosphonium 3-sulfopropyl acrylate (PSPA) represents the crosslinked matrix while the linear polymer is a poly(*N*-isopropylacrylamide-co-spiropyran-co-acrylic acid) p(NiPAAm-SA-AA) copolymer, which is both thermo- and photo-responsive. The thermal response is explained by the breaking of the hydrogen bonds, at temperatures above the lower critical solution temperature, formed between water and the p(NiPAAm-SA-AA) chains. This event is followed by a marked increase in the polymer's hydrophobicity, which translates into the precipitation of the polymer from its solution. The photo response is explained by the conformation change of the spiropyran unit. In the dark, the unit is present as the protonated merocyanine form, while under white light, it undergoes a transition to the spiro form, which is more hydrophobic. The research described here focuses on synthesizing sIPN hydrogels and characterising their photo-induced size changeds in the presence of water and NaCl solutions of different concentrations.

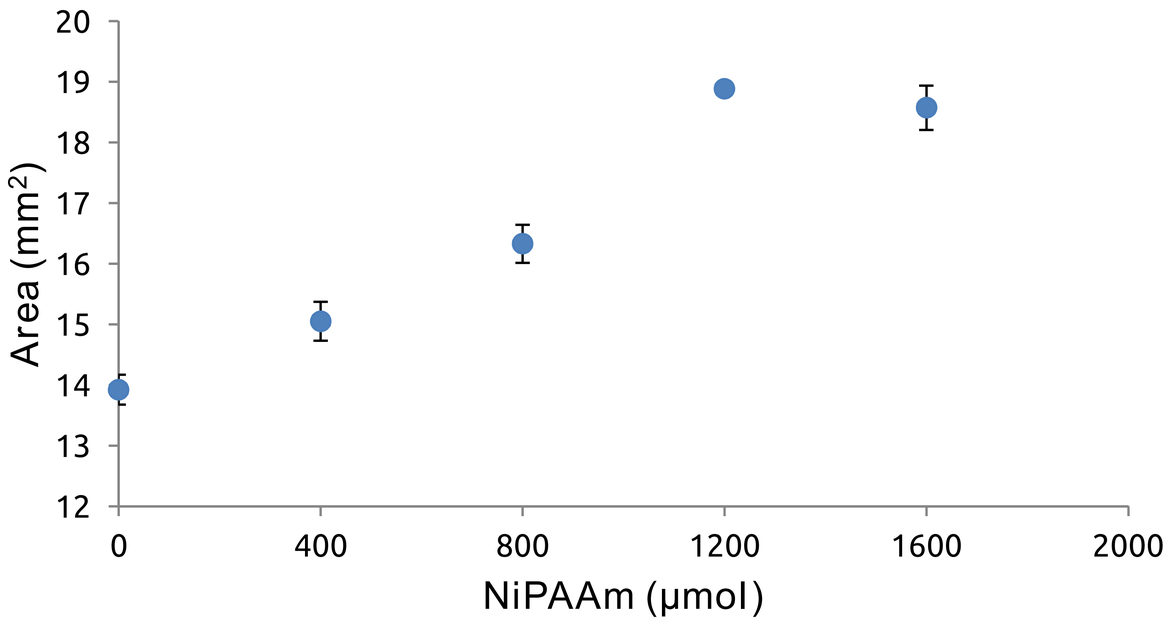
Material Synthesis



sIPN hydrogels having four different molar ratios of PIL:p (NiPAAm-SA-AA), 1:1, 1:2, 1:3 and 1:4, respectively, have been synthesised in 3mm diameter moulds. The resulting gels were immersed in deionized water and NaCl solutions of different concentrations - 0.5 wt%, 1 wt% and 5 wt% and left to hydrate for 18 hours. Measurements have been made to determine the area of the hydrogel in different illumination conditions.

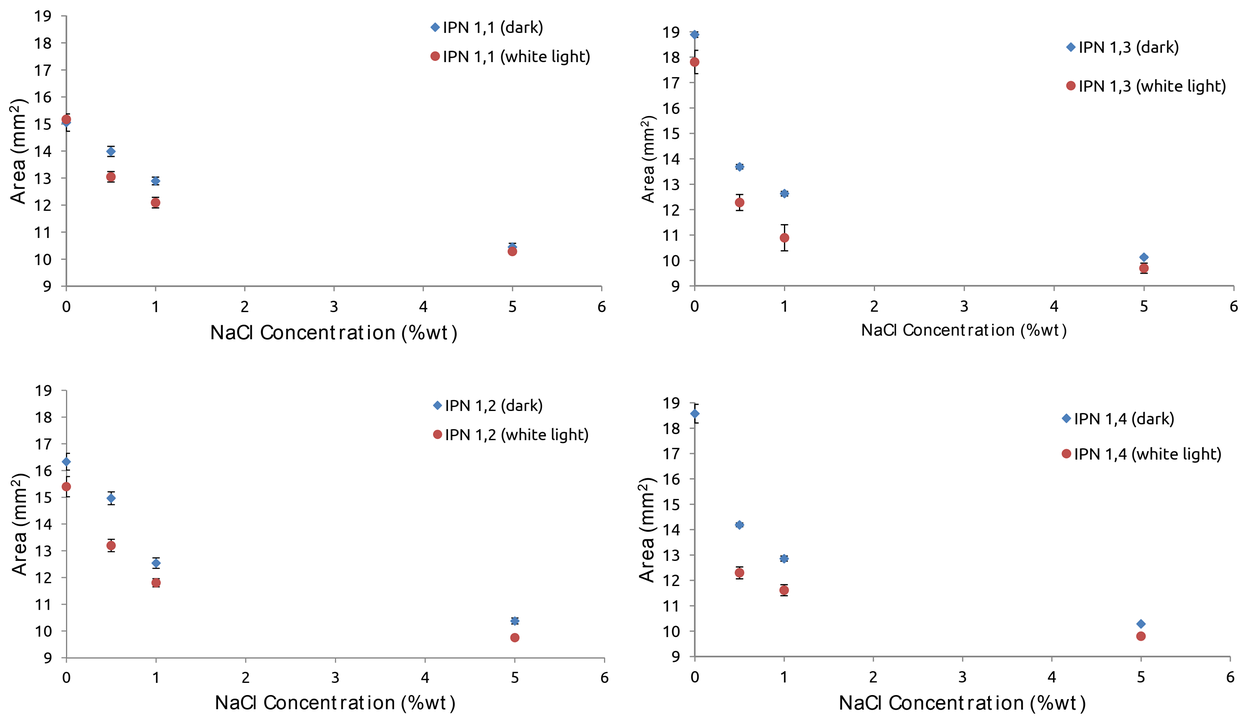


sIPNs - Effect of NiPAAm on hydration Capabilities



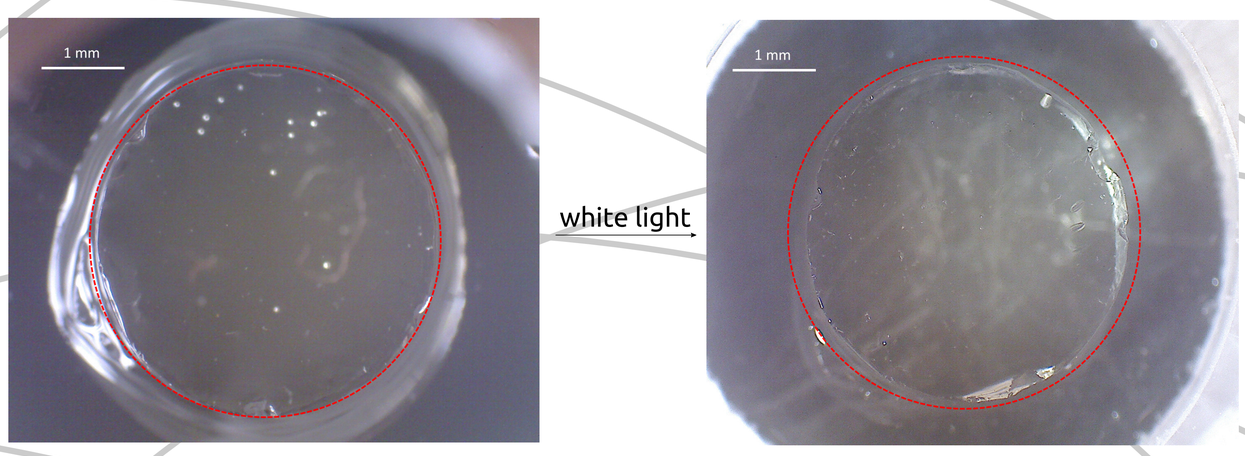
The area of each sIPN was measured after hydration in deionized water for 18 hours.

sIPNs - Photo-actuation Behaviour



The size of each hydrogel was studied before and after white light irradiation (30 minutes) in the presence of deionized water and NaCl solutions (0.5 wt%, 1 wt% and 5 wt%) . For each gel a series of three pictures were taken with a digital microscope, followed by measuring the area five times for each picture.

The following pictures are an example of the photo-induced shrinking. In this case, IPN 1,2, which was hydrated in a 0.5 wt% solution, was exposed to white light for 30 minutes.



Conclusions

A series of sIPNs were synthesized by using a PIL crosslinked matrix and a NiPAAm based thermo- and photo-responsive copolymer. The results confirmed that the presence of the copolymer increased the water intake of the sIPNs and it also confirmed that exposing the swollen hydrogels to white light caused an additional degree of shrinking, beyond that induced by increasing the NaCl concentration of their hydrating solution. This was consistent in all cases for NaCl concentrations up to 1% wt. Above this, the effect is reduced because of the extent of collapse of the gel structure was dominated by the NaCl effect alone.

Acknowledgements

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