Photo-responsive materials functionalised with spiropyran derivatives

Aishling Dunne, Wayne Francis, Siobhán Mac Ardle, Joseph Hennessy, Larisa Florea* and Dermot Diamond

Dublin City University, School of Chemical Sciences, Insight Centre for Data Analytics, National Centre for Sensor Research, Dublin, Ireland

Centre for Data Analytics

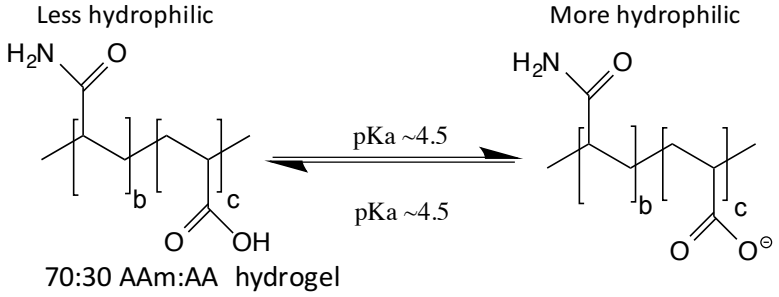
Insight

Introduction

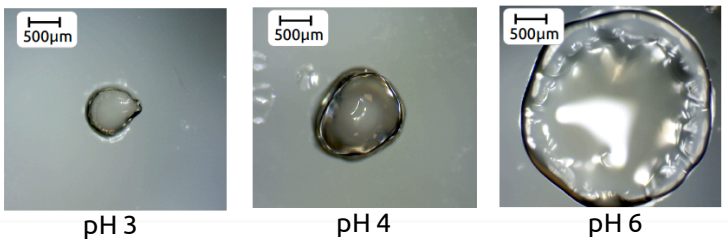
Photo-responsive hydrogels of varying compositions containing spiropyran (SP) photochromic units have been widely studied for their photo-actuation properties. In this study two hydrogel formulations were employed to produce reversible photo-responsive hydrogel actuators operative in neutral pH environments (poly(acrylamide-co-acrylic acid-co-SP) (poly (AAm-co-AA-SP)) and poly(N-isopropylacrylamide-co-acrylic acid-co-spiropyran acrylate (p(NIPAAm-co-AA-co-SP))).

Photo-responsive Hydrogels I

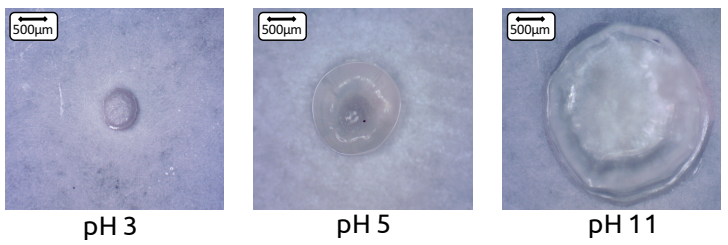
In p(AAm-co-AA-co-SP) hydrogels, the SP unit serves as a reversible photo-acid generator changing the local pH which in turn determines the ratio of AA/A- and therefore the hydrophilic character of the hydrogels.



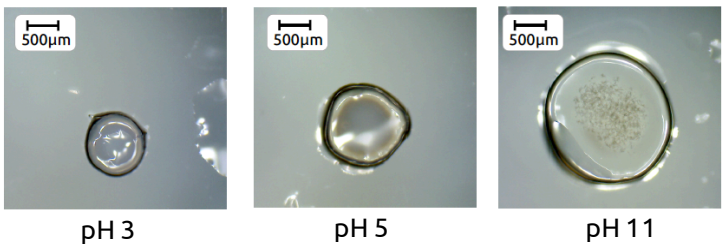
70:30 AAm:AA hydrogel



50:50 AAm:AA hydrogel



30:70 AAm:AA hydrogel



Within 90 s of white light irradiation, photo-contraction of ~15% in diameter is achieved. After a further ~30 s in the dark the hydrogel reswells to ~95% of its fully hydrated size.

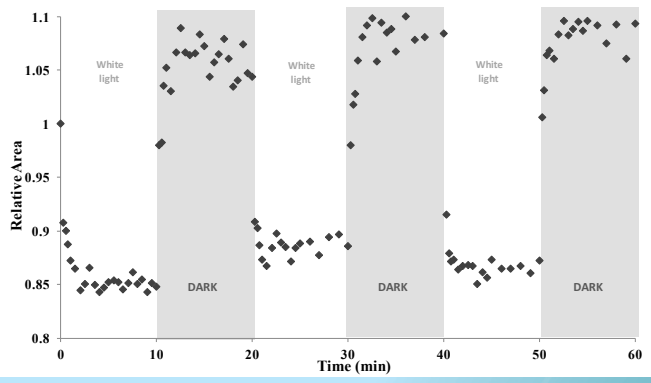
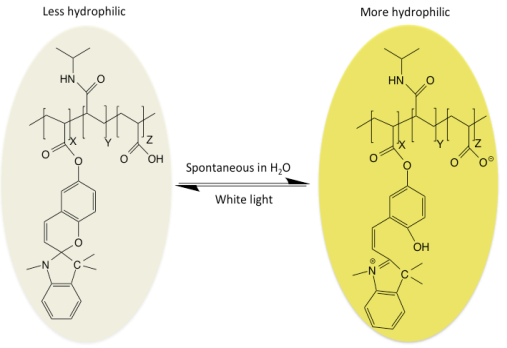
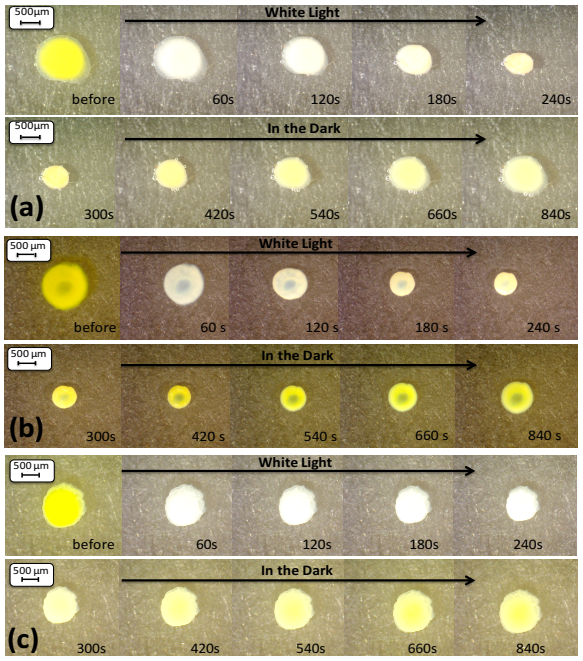
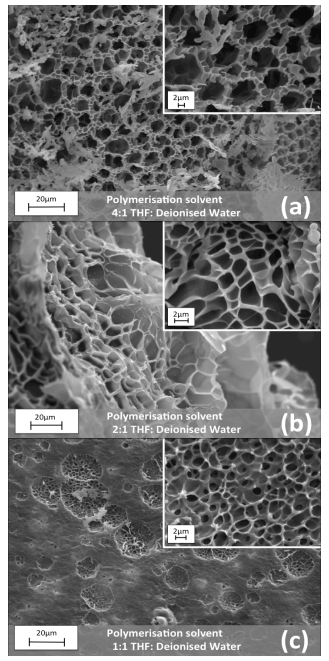


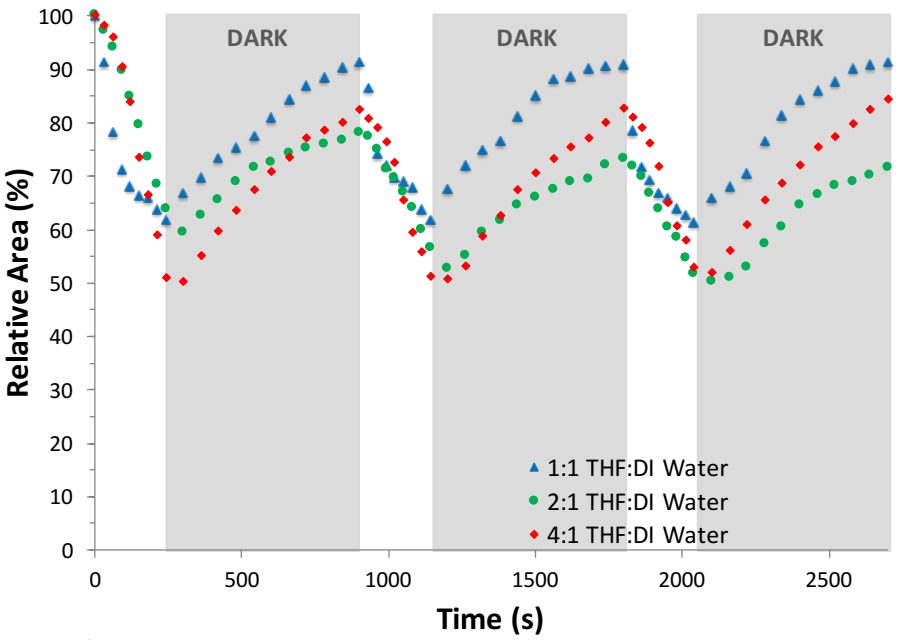
Photo-responsive Hydrogels II

In the case of p(NIPAAm-co-AA-co-SP) hydrogel, an area contraction of up to 45% of its fully hydrated size was achieved after 4 min of white light exposure followed by reswelling to up to 85% of the initial size after 11 min in the dark. Modulation of the shrinking /reswelling capabilities of the hydrogels was successfully accomplished by varying the polymerisation solvent mixtures.









Conclusions

In both cases the photo-induced contraction/reswelling processes were reversible and repeatable over at least 3 cycles with minimal hysteresis. These hydrogels were further used for the development of improved photo-responsive valves in microfluidic devices and micro-"walkers" capable of phototactic movement.

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