# Photo-responsive materials functionalised with spiropyran derivatives

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## Abstract:

Photo-responsive hydrogels of varying compositions containing spiropyran photochromic units have been widely studied in recent years due to their many potential applications, including photo-actuated micro-valves for microfluidic devices [1,2].

In this work two hydrogel formulations were developed producing reversible photo-responsive hydrogel actuators operative in neutral pH. Both compositions contain the photochromic unit spiropyran acrylate (SP) and acrylic acid (AA) copolymerised in the main polymer backbone, together with *N*-isopropylacrylamide (NIPAAm) or acrylamide (AAm), respectively. At neutral pH, the AA comonomer dissociates to the acrylate anion (A-) transferring the proton to the SP unit to give the more hydrophilic protonated merocyanine (MC-H+) form, which triggers water uptake and hydrogel expansion. Under white light irradiation, the MC-H+reverts to the more hydrophobic SP isomer with simultaneous reformation of acrylic acid. These simultaneous processes reduce the overall hydrophilicity of the polymeric chain through different mechanisms, triggering hydrogel contraction.

In the case of p(NIPAAm-*co*-AA-*co*-SP) hydrogel, the optimum composition has resulted in an area contraction of up to 45% of its fully hydrated size after 4 min of white light exposure, followed by reswelling to up to 85% of the initial size after 11 min in the dark.

In comparison, optimized p(AAm-*co*-AA-*co*-SP) hydrogels have resulted in contraction of ~15% in diameter within 90 seconds of white light irradiation followed by reswelling to ~95% of its fully hydrated size after ~30 seconds in the dark.

In both cases the photo-induced contraction/reswelling processes were reversible and repeatable over at least 3 cycles with no detectable hysteresis.

These hydrogels were further used for the development of improved photo-responsive valves in microfluidic devices and light guided “walkers” capable of phototactic movement.

### References:

[1] Ter Schiphorst, J., Coleman, S., Stumpel, J.E., Ben Azouz, A., Diamond, D., Schenning, A.P.H.J., 2015. Chem. Mater. 27, 5925–5931.

[2] Ziółkowski, B., Florea, L., Theobald, J., Benito-Lopez, F., Diamond, D., 2013. Soft Matter 9, 8754 – 8760.

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