

Photo-Responsive Hydrogels with Enhanced Volume Changes due to Local pH alterations

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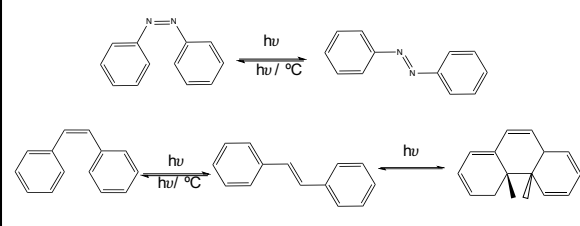
Overview

- Background
- *Solvato-Morphologically Controlled, Reversible NIPAAm Hydrogel Photo-actuators*
- *Photo-Responsive Hydrogels with Enhanced Volume Changes due to Local pH Alterations*
- *Potential Application*

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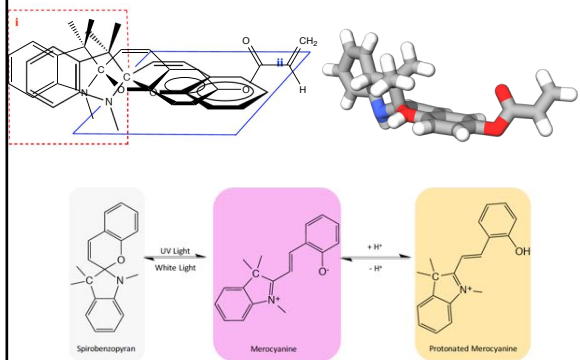
Photo-Responsive Hydrogels

- Volume changes with different illumination conditions
- Working principle: photochromic unit changing the hydrophilic character of the polymer chain
- Photochromic units:

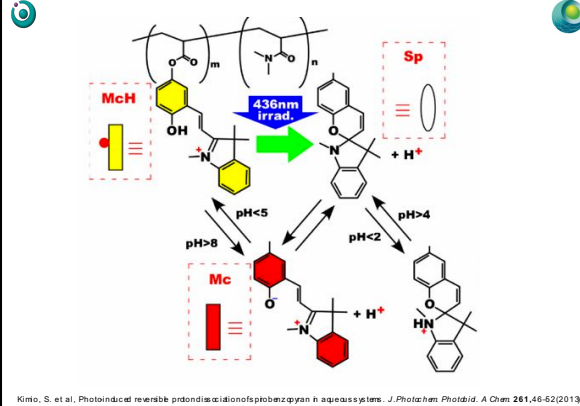


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Spirobenzopyran

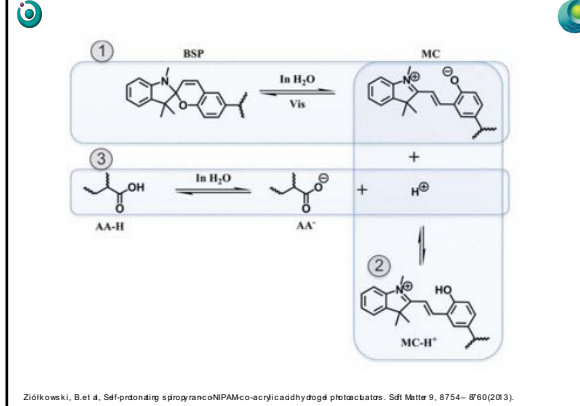


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Kim, S. et al. Photoinduced reversible protonation of spiropyran in aqueous systems. *J. Photochem. Photobiol. A Chem* 261, 46-52 (2013).

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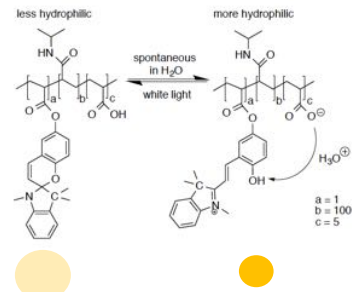
Ziólkowski, B. et al. Self-irradiating spiropyran-co-NIPAAm-acrylic acid hydrogel photoactuators. *Soft Matter* 9, 8754-8760 (2013).

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Solvato-Morphologically Controlled, Reversible NIPAAm Hydrogel Photo-actuators

Introduction

- Decrease actuation time
- Improve degree of volume changes



Rheology study

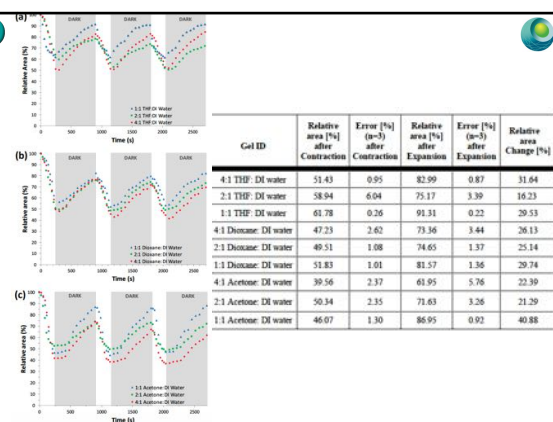
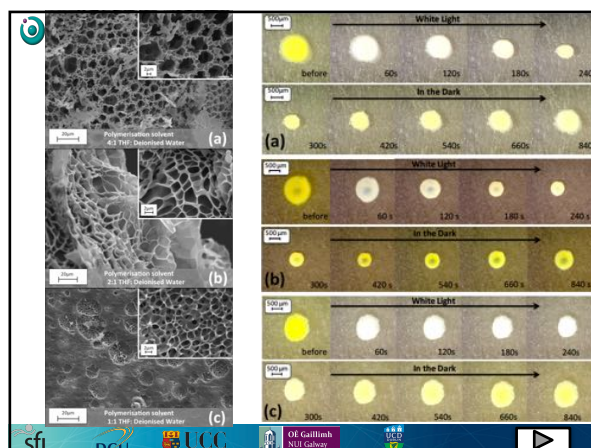
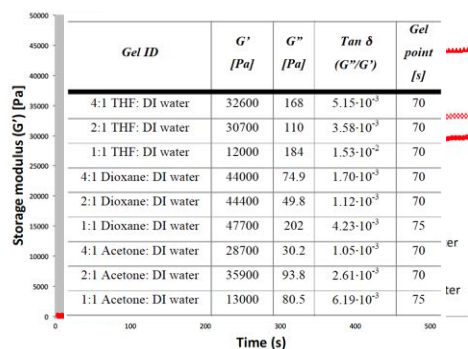


Photo-Responsive Hydrogels with Enhanced Volume Changes due to Local pH Alterations

Background

- Volume changes with changing pH
- Working principle: presence of ionisable groups
- Variety of pH-sensitive materials
- Conversion to photo-responsive by inclusion of photo-acid generator

Chemical reaction scheme showing the photo-responsive swelling of a hydrogel. The hydrogel backbone is shown with a photo-acid generator (PAG) attached. The PAG is activated by light to release a proton (H⁺), which then triggers the swelling of the hydrogel.

Legend: AA = monomer, A^- = polymer chain

Technical details: P. et al. *Proc. Natl. Acad. Sci. USA* 2010, 107, 11111-11116

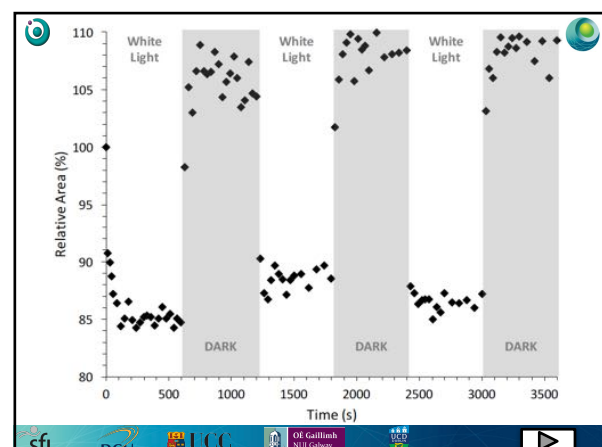
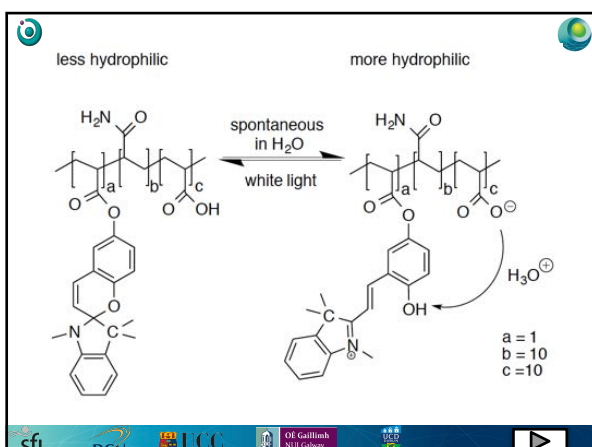
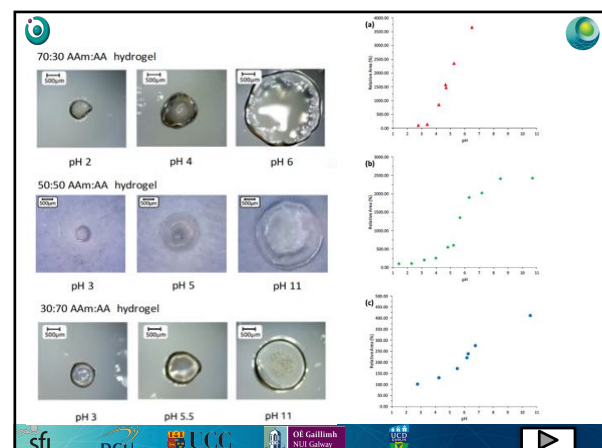
Less hydrophilic More hydrophilic

Chemical reaction scheme showing the photo-responsive swelling of a hydrogel. The hydrogel backbone is shown with a photo-acid generator (PAG) attached. The PAG is activated by light to release a proton (H⁺), which then triggers the swelling of the hydrogel.

Legend: AA = monomer, A^- = polymer chain

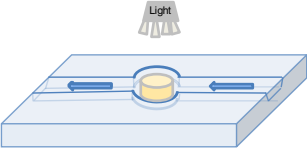
Technical details: P. et al. *Proc. Natl. Acad. Sci. USA* 2010, 107, 11111-11116

Chemical name	Molecular weight (g/mol)	Abbreviation	Mol ratio (%)
30:70 AAm:AA hydrogel			
Acrylamide	71.08	AAm	30
Acrylic acid	72.06	AA	70
Phenyl (2,4,6-trimethyl benzoyl) phosphine oxide	418.16	PBPO	1
Poly ethylene glycol	258	PEG 258	1.5
Solvent: 1:1 THF: DI Water (500 μ l)			
50:50 AAm:AA hydrogel			
Acrylamide	71.08	AAm	50
Acrylic acid	72.06	AA	50
Phenyl (2,4,6-trimethyl benzoyl) phosphine oxide	418.16	PBPO	1
Poly ethylene glycol	258	PEG 258	1.5
Solvent: 1:1 THF: DI Water (500 μ l)			
70:30 AAm:AA hydrogel			
Acrylamide	71.08	AAm	70
Acrylic acid	72.06	AA	30
Phenyl (2,4,6-trimethyl benzoyl) phosphine oxide	418.16	PBPO	1
Poly ethylene glycol	258	PEG 258	1.5
Solvent: 1:1 THF: DI Water (500 μ l)			



Possible applications

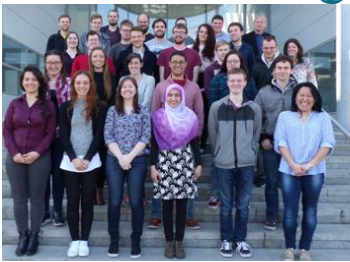
- Photo-actuated micro-valves in microfluidic devices



The diagram illustrates a microfluidic device with a central channel. A light source, labeled 'Light', is positioned above the channel. The channel contains a valve mechanism, represented by a yellow cylinder, which is flanked by blue arrows indicating the direction of fluid flow. The device is shown in a 3D perspective view.

Thank you

- Dr. Larisa Florea
- Dr. Colm Delaney
- Dr. Simon Coleman
- Dr. Bartosz Ziotkowski
- Prof. Dermot Diamond
- Research team
- NCSR, DCU
- Science Foundation Ireland & INSIGHT Centre
- Enterprise Ireland



A group photo of the research team, consisting of approximately 15 individuals, standing on a set of stairs. They are dressed in a mix of casual and professional attire. The photo is taken outdoors, with a building visible in the background.