Fondúireacht Eolaíochta Éireann
Science Foundation Ireland

Stimuli responsive materials for sensors & actuators

CLARITY
clarity-centre.org

ATWARM

Bartosz Ziółkowski, Kevin J. Fraser, Robert Byrne, Fernando Benito-Lopez and Dermot Diamond

Introduction:

Current flow control solutions in analytical platforms have high power consumption and are prone to mechanical failure.

To scale down such analytical platforms and enable them to be incorporated into wireless sensor networks one needs revolutionary flow manipulation solutions[1]. Such solutions may come in the form of stimuli responsive materials.

Novel stimuli-responsive materials can:

- Shrink
- Bend
- Move

After appliying:

- Light
- Magnetic field
- Heat

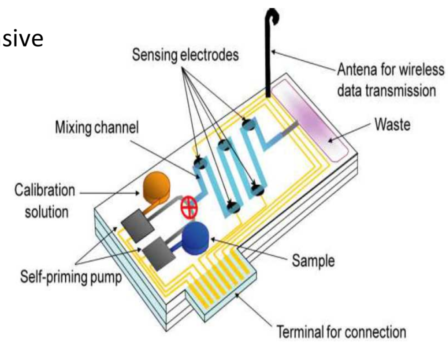

Fig 1. Exampleschematic of a wireless sensor platform

• Using flow controllers made out of there material will dramatically reduce power consumption and size of the full device. (Fig. 1)

•Research in this field will allow better water quality and environment monitoring.

Aim:

• Generate and control liquid flow within microfluidic manifolds using smart, stimuli responsive materials.

• Development and characterisation of magnetic responsive materials

• Development and characterisation of photo responsive materials

• These are to be used later in a parallel project aimed at manufacturing actuators for microfluidics.

Experimental:

Magnetic responsive material

• Magnetic Fe3O4 particles were coated with polymer linking groups (Fig. 2)

• These coated particles and an acrylamide monomer were dissolved in a hydrophobic ionic liquid[2] and then heated to form a soft magnetically actuated gel (Fig. 3)

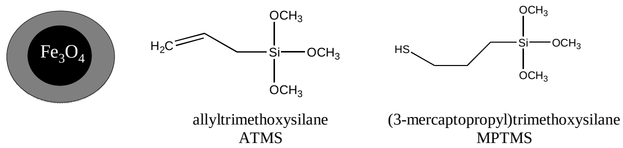

Fig. 2. Schematic of the final nano particle. The grey outer shell consists of ATMS or MPTMS.

Light responsive material:

• The same acrylamide and ionic liquid were linked with a light responsive spiropyran molecule

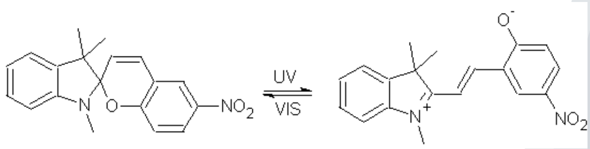

Fig. 3. The spiropyran molecule opens up in ultraviolet light and closes in visible light

Results:

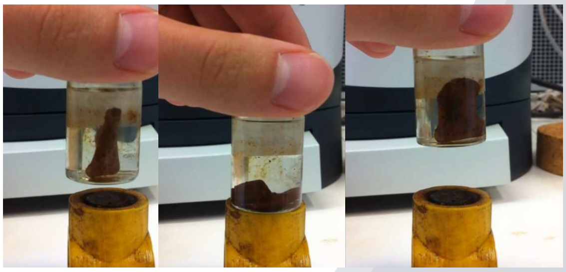

Fig. 4. Magnetic gel contracts rapidly after placing above a permanent magnet but after removing the magnetic field the gel returns to its original shape quickly and reversibly

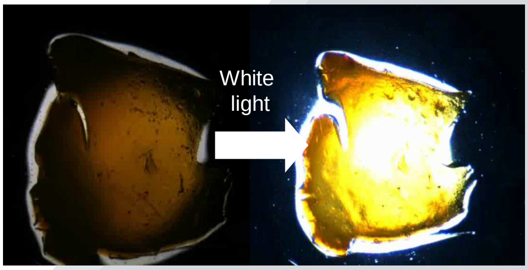

Fig. 5. The photo-responsive gel shrinks as the contained spiropyran molecule closes in white light [3]. In this example the volume of the gel decrease by 30 %.

Conclusions:

• Magnetically actuated gels will be incorporated into microfluidic devices as pumping elements

• Photo-shrinking soft gels can work as valves in analytical device's sampling channels

• Both materials require minimum energy to activate: permanent magnets and low power consumption LEDs

• Non toxic and hazardous substances contained in these materials allow them to be used in environment monitoring

Funding Acknowledgement

This work is supported by the ATWARM grant (Marie Curie ITN, No. 238273)
R. B., and D. D. acknowledge funding from Science Foundation Ireland (SFI) under the CLARITY CSET award (Grant 07/CE/I1147)

[1] R. Byrne, F. Benito-Lopez and D. Diamond, *Mater. Today*, 2010, **13**, 9-16.
[2] K. J. Fraser and D. R. MacFarlane, *Aust. J. Chem., 2009*, ***62, 309-321.***
[3] F. Benito-Lopez, R. Byrne, A. M. Raduta, N. E. Vrana, G. McGuinness and D. Diamond, *Lab Chip*, 2010, **10**, 195-201.

MARIE CURIE ACTIONS
Marie Curie Initial Training Network

UNIVERSITY COLLEGE DUBLIN • DUBLIN CITY UNIVERSITY • TYNDALL NATIONAL INSTITUTE

QUESTOR CENTRE

SEVENTH FRAMEWORK PROGRAMME