

Bartosz Ziólkowski, 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 applying:  
Light  
Magnetic field  
Heat

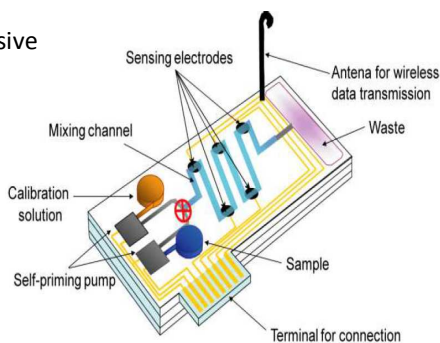


Fig 1. Exampleschematic of a wireless sensor platform

• Using flow controllers made out of these 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 Fe<sub>3</sub>O<sub>4</sub> 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)

### 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)

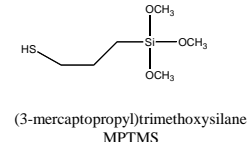
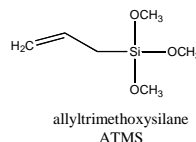


Fig. 2. Schematic of the final nano particle. The grey outer shell consists of ATMS or MPTMS.

### Light responsive material:

- The same acrylamide and ionic liquid were linked with a light responsive spiroopyran molecule

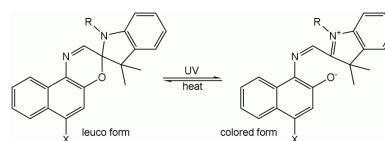


Fig. 3. The spiroopyran molecule opens up in ultraviolet light and closes in visible light

## Results:

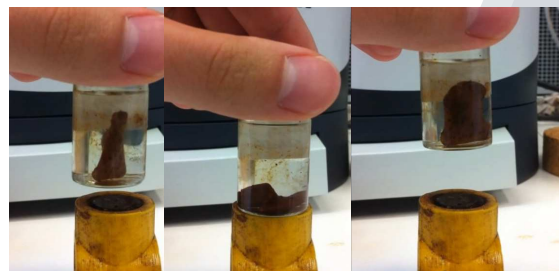


Fig. 4. Magnetic gel contracts rapidly after placing above a permanent magnet but after removing the magnetic field the gel returns to its original shape quickly and reversibly

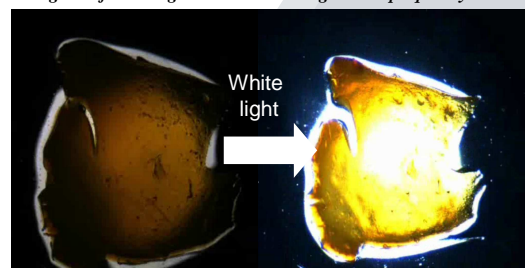


Fig. 5. The photo-responsive gel shrinks as the contained spiroopyran molecule closes in white light [3]. In this example the volume of the gel decrease by 30 %.

## 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