ATWARM

Advanced Technologies for Water Resource Managemer

Magneto-responsive ionogels for microfluidic fluid manipulation

Bartosz Ziółkowski, Robert Byrne and Dermot Diamond

CLARITY: Centre for Sensor Web Technologies, National Centre for Sensor Research, Dublin City University, Dublin 9, IRELAND

Project Objectives

Current sample flow control in analytical platforms is managed by conventional micro-pumps and micro-valves. These, like their conventional size equivalents, have considerable power consumption, cost and are composed of moving parts that can always fail.

In order to scale down such analytical platforms and mass produce devices that can be incorporated into wireless sensor networks one needs revolutionary flow manipulation solutions.[1] In recent years a lot of research has been done in the field of stimuli-responsive materials. These materials can react to changes in the environment because of their inherent properties and functionalities.[2] Ideally, for such material to perform its function no additional energy is required apart from the one coming from the environmental stimulus. Using flow controllers made out of a material like this would dramatically reduce power consumption and size. Therefore, research in this field is crucial for development of sensor platforms. This in turn will allow better water quality and environment monitoring. Therefore, the objectives of our research are:

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

- Synthesize and characterise novel polymerisable magnetic particles
- Synthesize and characterise polymeric ionogels
- Combine the magnetic materials with the polymeric ionogels to afford a hybrid magneto-responsive material
- Develop a precursor mixture that can be photo-patterned inside a channel

This material will allow fabrication of pump and valve structures inside microfluidic analytical manifolds. Such flow controllers will be actuated by external magnetic fields. This approach avoids sample contamination and limits the amount of moving parts in the device.

Future work and training

- Photopatterning the ionogels inside microfluidic channels
- Performing magnetic functionalisation chemistry inside the channels
- Fabrication and testing of magneto-responsive valves
- Functionalising magnetic particles with vinyl groups and copolymerisation with the gel
- Thermal Analysis Workshop (18.04.2011) and Dynamic Mechanical Analysis (May 2011)
- Euromat 2011, 12-15 September, Montpelier, France

References:

1. Byrne, R.; Ventura, C.; Lopez, F. B.; Walther, A.; Heise, A.; Diamond, D. *Biosens. Bioelectron.* **2010**, *26*, 1392.
2. Byrne, R.; Benito-Lopez, F.; Diamond, D. *Materials Today* **2010**, *13*, 9.

Results

- The synthesised magnetic nanoparticles, due to their size, have high magnetic susceptibility but no magnetic memory at room temperature. This allows them to respond to magnetic fields but relax immediately once the magnetic field is removed

- Characterisation of magnetic particles (SEM, DLS)

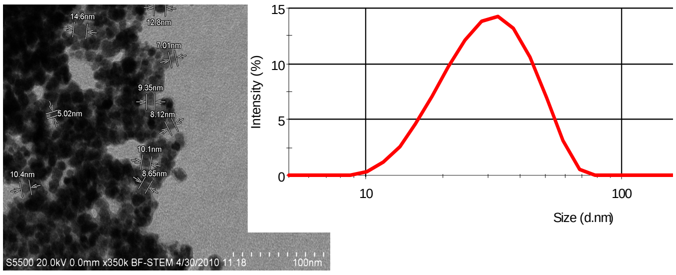

Fig. 1. Left: SEM picture of the magnetic nanoparticles; Right: DLS size distribution of the particles

- Gels synthesised in the ionic liquid do not dry out due to the ionic liquid low vapour pressure

- These ionic liquid swollen gels keep their mechanical characteristics compared to water swollen gels

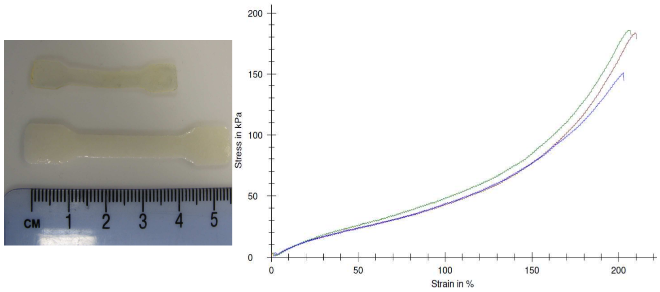

Fig. 2. Left: Dry and swollen ionogel samples; Right: Tensile tests of the ionogel swollen only with the ionic liquid.

- Magnetic susceptibility of the synthesized ionogels will allow moving valve and pump gel elements inside the channel remotely through the channel wall

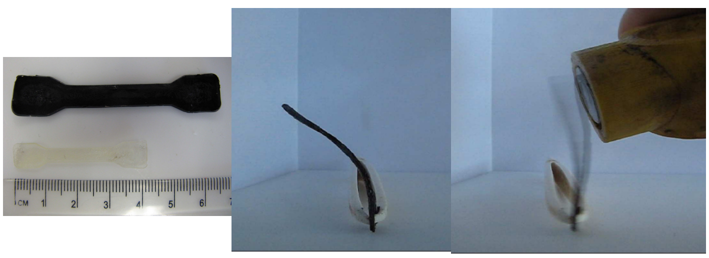

Fig. 3. Left: Dry ionogel and swollen ionogel loaded with magnetic particles; Right: Response of the magnetic ionogel to an external mangetic field

MARIE CURIE ACTIONS
Marie Curie Initial Training Network
CLARITY
clarity-centre.org
ATWARM
PEOPLE