Next generation autonomous analytical platforms for remote environmental monitoring:

Microfluidic platforms incorporating stimulus-responsive materials for Water Quality

Bartosz Ziółkowski
Dermot Diamond
Presentation outline

1. Project background

2. Results and progress

3. Training and outputs
Project background

The 20 € autonomous environmental sensor…
Project background

• To be able to miniaturise and mass produce these devices we need:

  • New smart materials for sample handling
  • Soft gel able to swell in a microfluidic channel
  • Shrinking under temperature and light stimulus

Photoresponsive gel based on poly(N-isopropylacrylamide) copolymerised with spiropyran

Benito-Lopez, F. et al.
Lab on a Chip 2010, 10, 195.
Project background
New gel-like materials

Soaking (H₂O)

Drying

Electrochemical Stability
High Ion Conductivity
Thermal Stability
Non-Flammability
Chemical Stability

Ionic Liquid in Macromolecular Network

Flexible, Transparent Solid Membrane

Ionic Liquid

Ion Gel
Project background

Ionogels as platforms for stimulus responsive materials
Results and progress

Understanding and tuning of mechanical properties

UV curing rheometry of ionogels

DSC polymerisation kinetics analysis
Results and progress

Real time analysis of ionogel curing

![Graph showing the real-time analysis of ionogel curing with UV on. The x-axis represents time in minutes, ranging from 0 to 75, and the y-axis represents the relative loss modulus in Pa/Pa, ranging from 0 to 6000. The graph illustrates the curing process as UV is activated.](chart.png)
Results and progress

Magnetic gels

polymer
gel
matrix

Bare particles
VS
Coated particles

Fe₃O₄
Results and progress

Magnetic gels
Results and progress

Novel thermo responsive polymeric materials

These temperature responsive liquids can form temperature responsive polymers and gels

Results and progress

Thermo responsive polymeric ionic liquids

Adding photoswitch molecule to the gel structure creates a thermo and photo responsive material.
There are challenges though:

The current formulations do not allow to actuate the gel at room temperature

The stiffness of the gel network prevents high volume swelling

Currently other gel materials are being investigated
  lower response temperature
  lower stiffness

All of these materials are constantly being screened vs project 3.8
Results and progress
Expertise covered

• UV and Vis curing of polymers

• Mechanical profiling of materials and their curing behaviour

• Polymer mechanical properties tuning

• Magnetic-polymer composites

• Thermo responsive polymers and gels

• Conductive polymeric materials

• Potential materials for inexpensive autonomous environmental microfluidic sensor
Training and outputs

CIMTEC conference, June 2012 Montecatini, Italy. Talk presented “Magnetic ionogels for fluid handling in microfluidic devices”

ESOF conference, July 2012 Dublin.


Supervision of Erasmus Placement student from Ecole Nationale Supérieure des Ingénieurs en Arts Chimiques Et Technologiques, Toulouse, France

“Magnetic Ionogels (MagIGs) Based on Iron Oxide Nanoparticles, Poly(N-isopropylacrylamide), and the Ionic Liquid Trihexyl(tetradecyl)phosphonium Dicyanamide, Bartosz Ziółkowski, Katrin Bleek, Brendan Twamley, Kevin J. Fraser, Robert Byrne, Dermot Diamond and Andreas Tauber, European Journal of Inorganic Chemistry, Article first published online: 29 August 2012, DOI: 10.1002/ejic.201200597)

“Mechanical properties and U.V. curing behaviour of Poly(N-isopropylacrylamide) in phosphonium based ionic liquids” Manuscript submitted to Macromolecular Chemistry and Physics
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Thank you for attention!