

project 3.7

**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

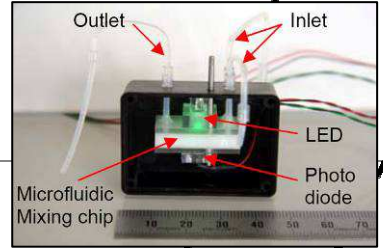
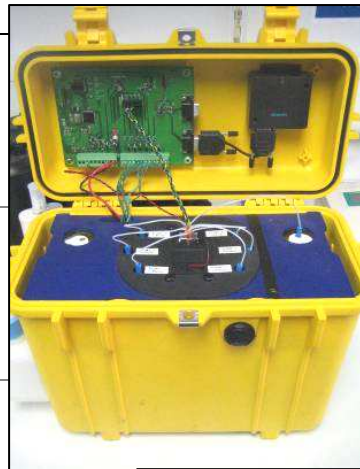
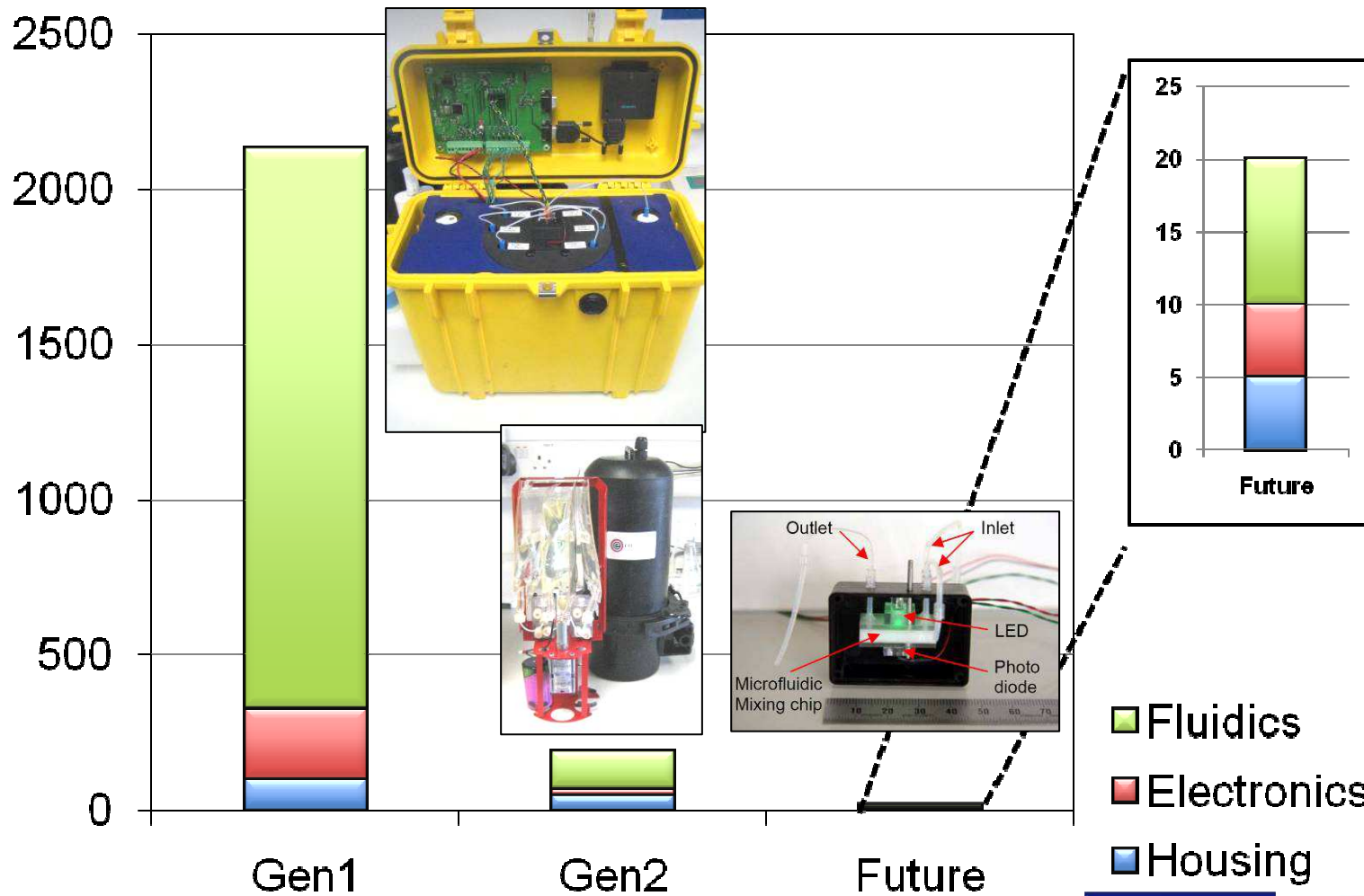
2. Results and progress

3. Training and outputs



Project background

The 20 € autonomous environmental sensor...



- Fluidics
- Electronics
- Housing



- **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**



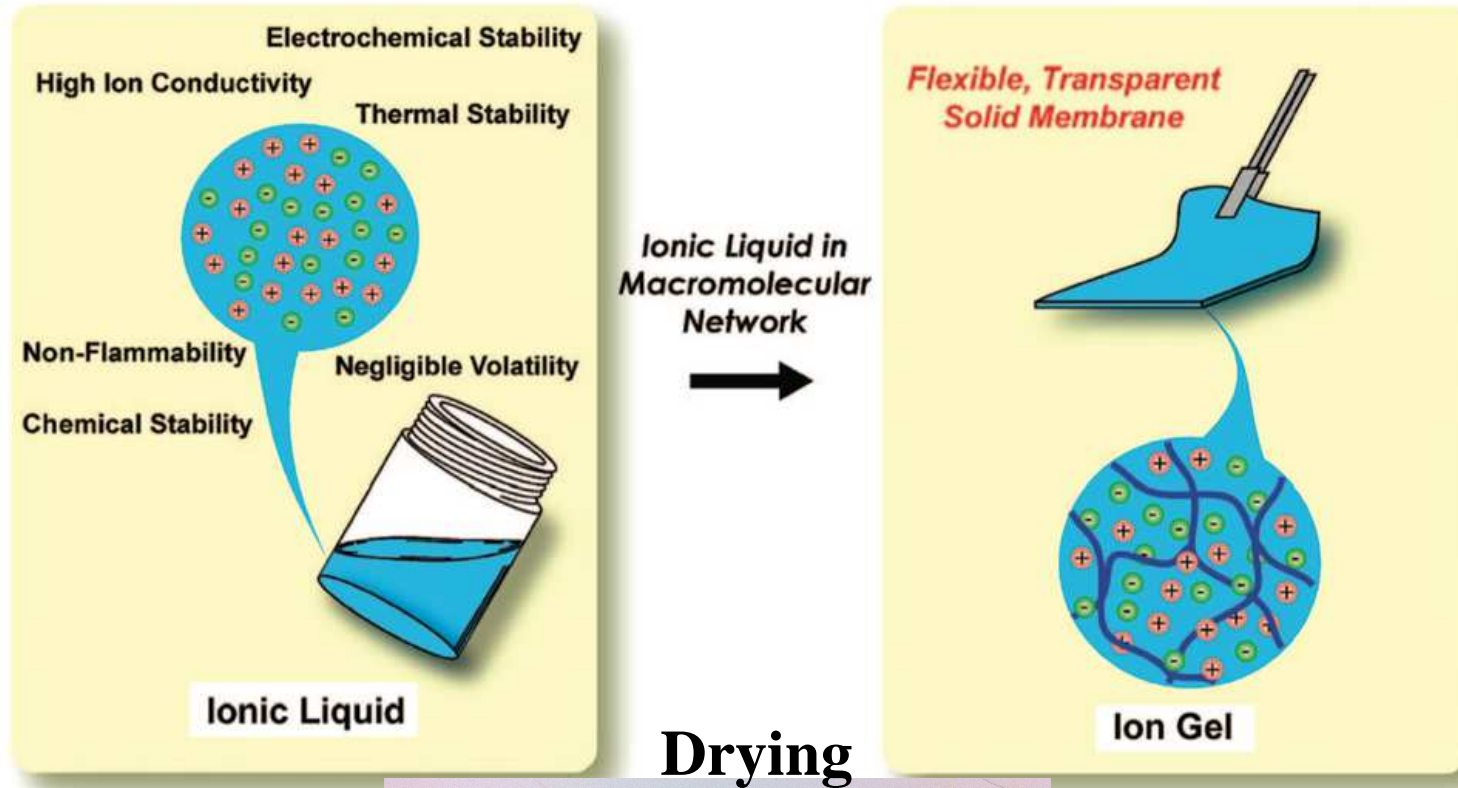
Photoresponsive gel based on poly(N-isopropylacrylamide) copolymerised with spiropyran

Benito-Lopez, F. *et al.*
Lab on a Chip 2010, 10, 195.



Project background

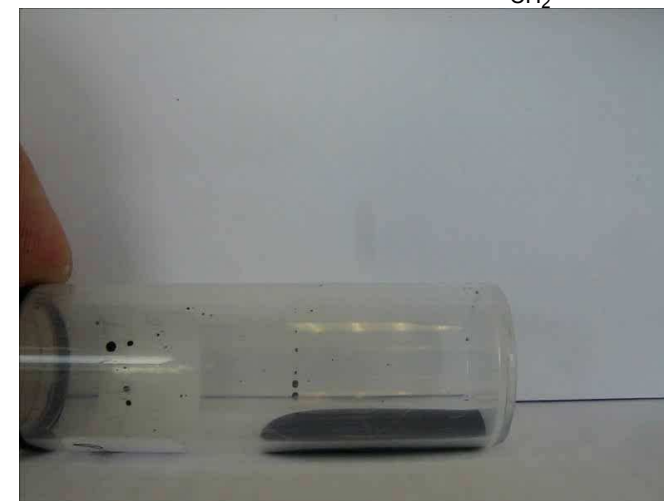
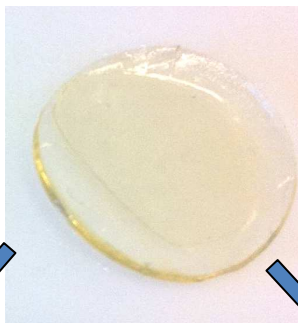
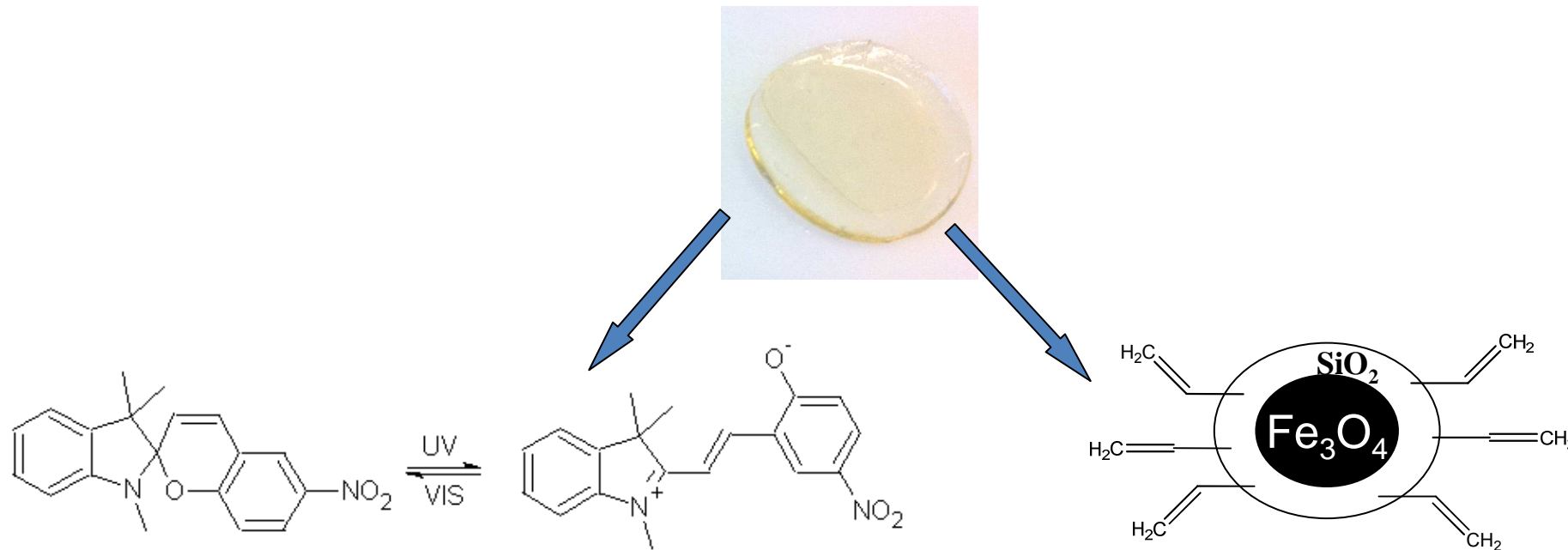
New gel-like materials



Soaking (H₂O)

Project background

Ionogels as platforms for stimulus responsive materials



Understanding and tuning of mechanical properties

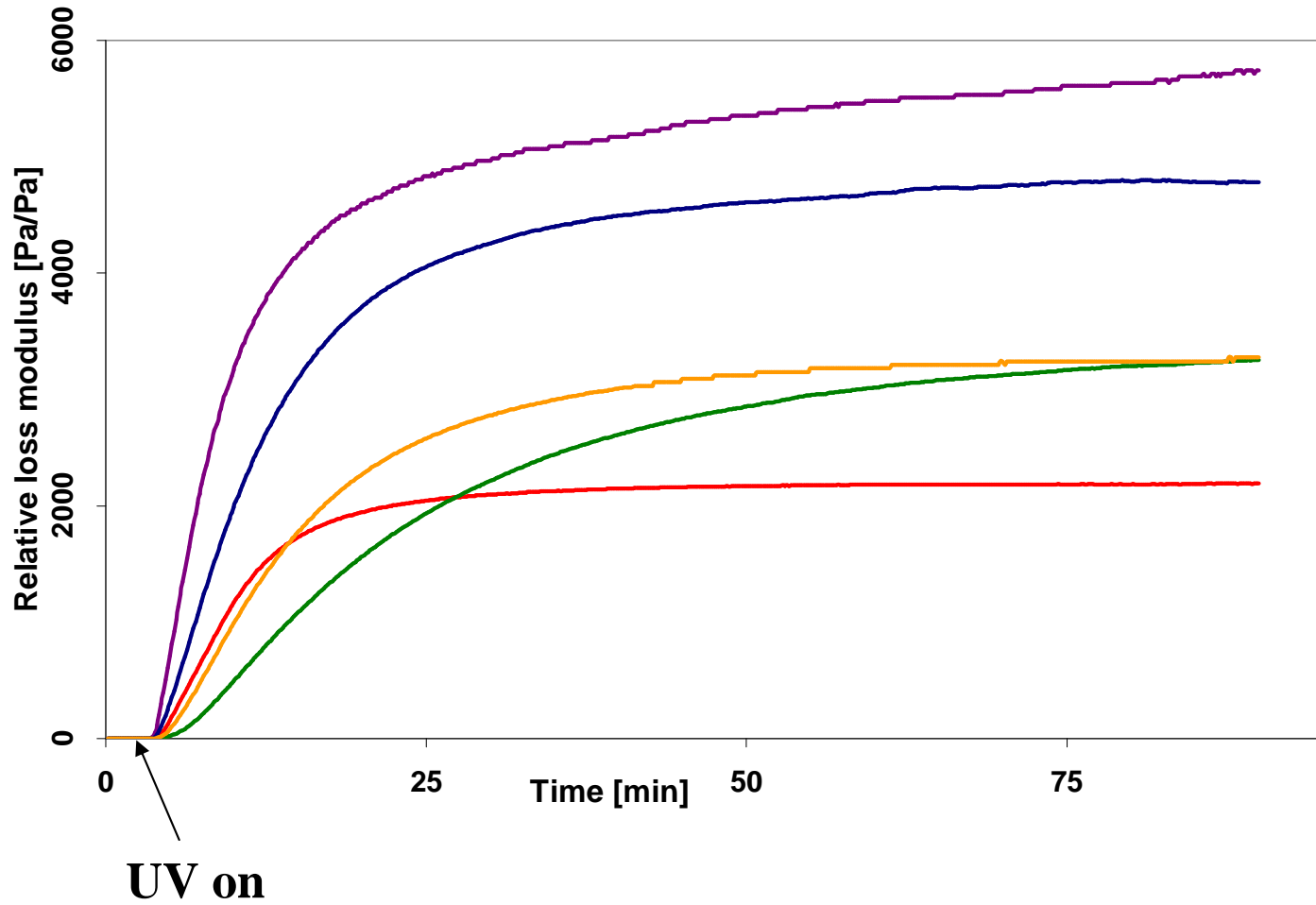


UV curing rheometry of ionogels



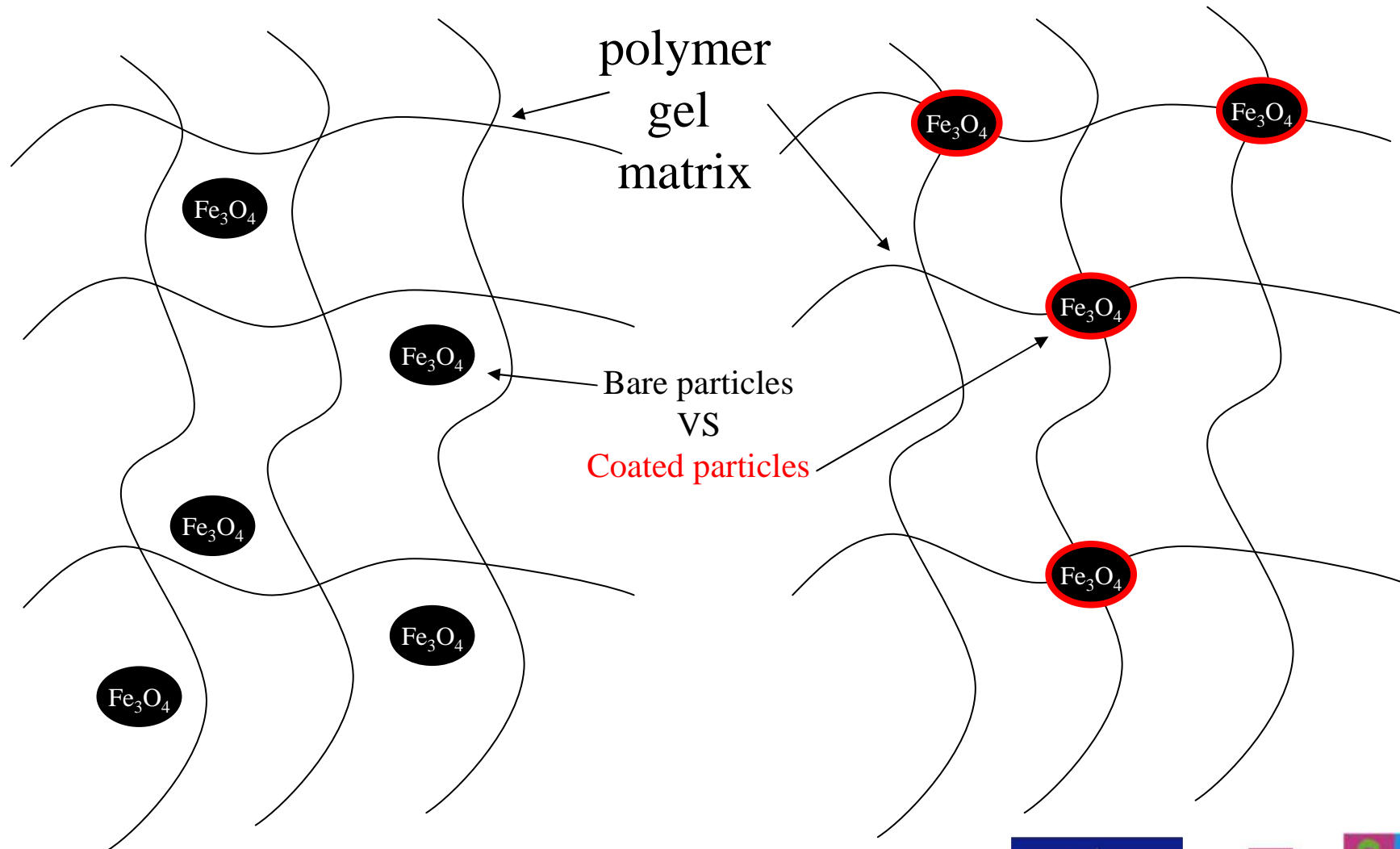
DSC polymerisation kinetics analysis

Real time analysis of ionogel curing



Results and progress

Magnetic gels



Results and progress

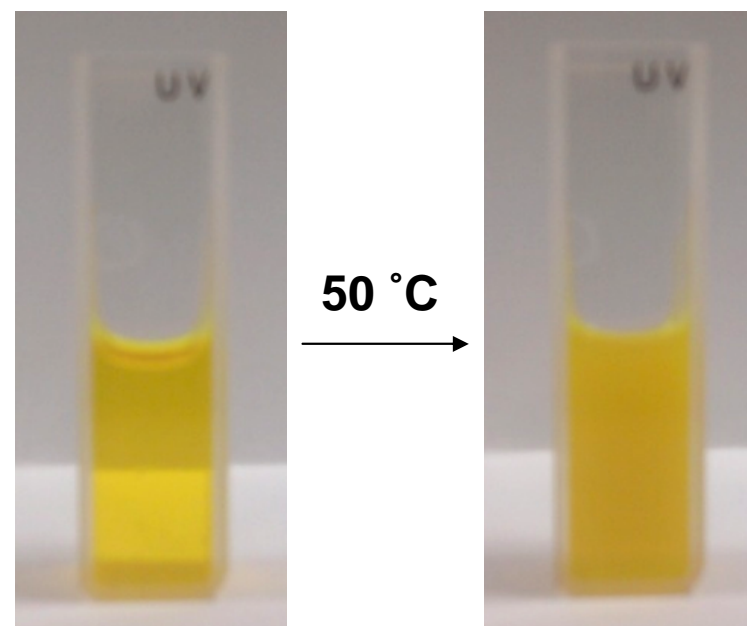
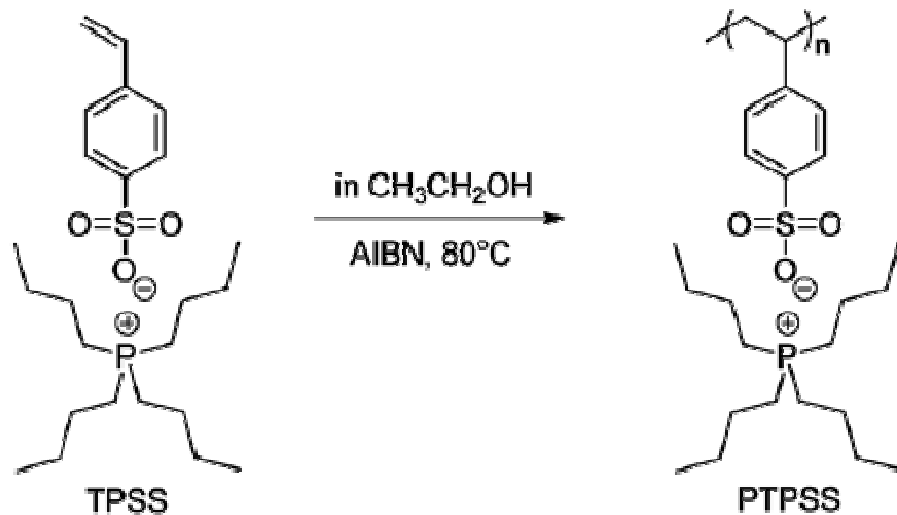
Magnetic gels



Results and progress

Novel thermo responsive polymeric materials

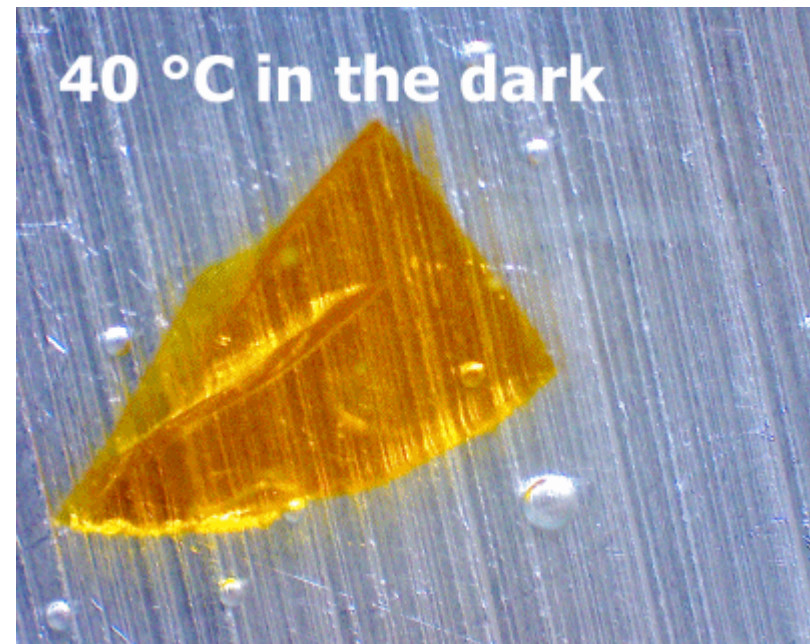
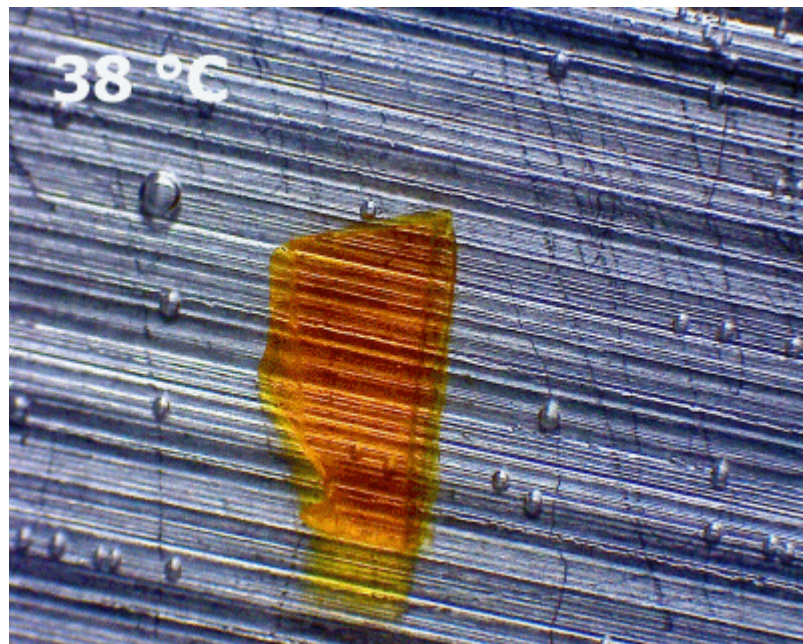
These temperature responsive liquids can form
temperature responsive polymers and gels



Y. Men, *et al.*, „Poly(tetrabutylphosphonium 4-styrenesulfonate): a poly(ionic liquid) stabilizer for graphene being multi-responsive”, *Polymer Chemistry*, vol. 3, n°. 4, p. 871, 2012.

Thermo responsive polymeric ionic liquids

Adding photoswitch molecule to the gel structure creates a thermo and photo responsive material



Thermo responsive polymeric ionic liquids

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**



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

ESOF conference, July 2012 Dublin.

**2nd International Symposium on Functional Nanomaterials, September 2012
Dublin. Poster: “Synthesis and characterisation of photo-responsive
hydrogels”**

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

Training and outputs



“Integrating stimulus responsive materials and microfluidics: The key to next-generation chemical sensors”, Bartosz Ziółkowski, Monika Czugała and Dermot Diamond, *Journal of Intelligent Material Systems and Structures* **published online 27 September 2012** DOI: 10.1177/1045389X12459591

“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 Taubert, *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**



Acknowledgements

Dr. Kevin Fraser
Dr. Robert Byrne
Dr. Fernando Benito-Lopez
Prof. Dermot Diamond
Prof. Andreas Taubert

Colleagues from the NCSR

FP7 ATWARM grant (Marie Curie ITN, No. 238273).



Thank you for attention!

