ATWARM

Advanced Technologies for Water Resource Management

Next Generation Autonomous Analytical Platforms for Remote Environmental Monitoring

Generation of Fully Functioning Biomimetic Analytical Platforms for Water Quality

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Introduction

The development of fully integrated microfluidic devices is still hindered by the lack of robust fundamental building blocks for fluid control. In these devices, valves and pumps are essential for the low control in the microchannels, while simultaneously minimising dead volume. Applications of microvalves and pumps include flow regulation, on/off switching and sealing of liquids and gases. One of the most attractive ways of fluid manipulation on integrated microfluidic platforms is light irradiation, which allows not only for non-contact operation but also independent and remote manipulation of multiple fluids.

Microchip with photoswitchable ionogel microvalves

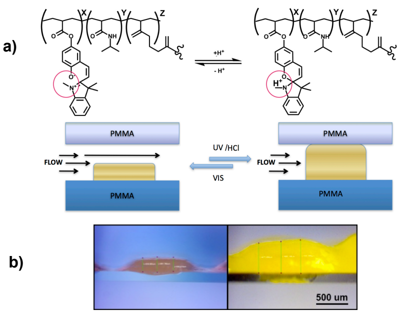

Fig. 1. a)Scheme of the photoswitchable polymer matrix and schematic of the valve actuation. b) Ionogel microstructure after photopolymerisation (left), and immersion in 1 mM HCl for 2 h (right).

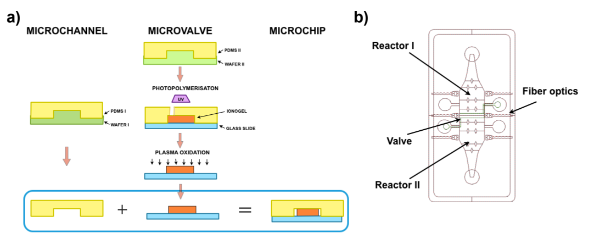

Fig. 2. a) Schematic representation of the microfluidic device fabrication protocol. b) Design of the microfluidic device fabricated in PDMS/glass.

Fiber Optic setup

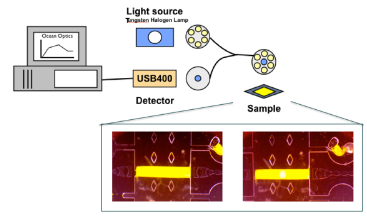

Fig. 3. Fiber Optic set-up with splitted fiber for actuation of ionogel valve $[P_{6,6,6,14}][dca]$ and obtaining kinetic data of its actuation.

Results

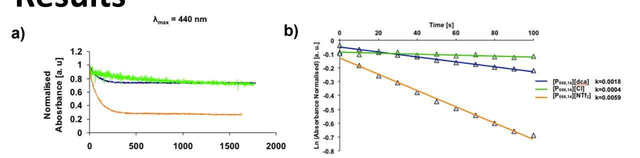

Fig. 4. a) Shrinking kinetic process of the three ionogel valves, b) First order kinetic study of the ionogel valves measured at 20 ± 0.5 ºC.

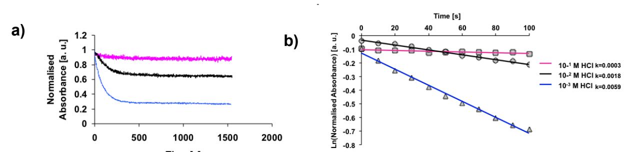

Fig. 5. A) Kinetic study for three different concentrations of HCl for the $[P_{6,6,6,14}][NTf_2]$ ionogel and b) First order kinetic study for three concentrations of HCl measured at 20 ± 0.5 ºC.

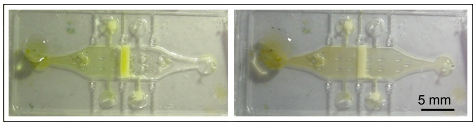

Fig.6. Microchip with $[P_{6,6,6,14}][NTf_2]$ ionogel microvalve in closed (left) and opened (right) state.

Career development

Publications

- **M. Czugala** *et. al.*, Integrating stimulus responsive materials and microfluidics – The key to next generation chemical sensors, JIMSS (10.1177/1045389X12459591)
- **M. Czugala** et. al., Novel optical sensing system based on wireless paired emitter detector diode device for Lab-on-aDisc water quality measurements. Lab Chip, 23 (2012) 5069

Conferences

- 6th International Conference on Environmental Science and Technology 2012, June 25-29, 2012, Houston, USA *(ORAL)*
- Sino-European Symposium on Environment and Health, 20-25 Aug 2012, Galway, Ireland *(ORAL)*
- The 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, 28 Oct - 1 Nov, 2012, Okinawa *(ORAL)*

Conclusions

Fabrication of the photoswitchable ionogel microstructures was successfully optimised, followed by the incorporation of the ionogel microstructures within hybrid PMDMS/glass microchip. Preliminary studies showed a three-dimension change of the valve due to the protonation and the deprotonation processes during white light irradiation. The biggest height change as well as the shortest shrinking time was observed for $[P_{6,6,6,14}][NTf_2]$ ionogels. This novel technology would take advantage of the unique properties of these materials, allowing for non contact and non invasive valve control within microfluidic devices.

Acknowledgements

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MARIE CURIE ACTIONS

PEOPLE

Marie Curie Initial Training Network