Photoactuated Ionogel Microvalves for Water Quality on-Chip Analysis

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Research Objectives

• Integration of actuators developed in Task 3.7 into a microfluidic platform:
  - biomimetic structures with detectors
  - fluidic manifolds
  - integral reagent addition and calibration standards
  - integral electronics
  - communications and power generation/storage

• Demonstration of fully functioning analytical platform.

• **pH and turbidity** - indicate that corrective action and investigation is required before it becomes a potential risk
  - associated with outbreaks of *Cryptosporidium* (Carlow in 2006 and Galway City in 2007)

• **nitrite** - in public health terms is essential as prolonged exposure can lead to a potential health risk

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Photo-responsive micro-valves

- Photoswitchable materials - the use of non-contact, non invasive stimuli.
- Ionogels containing spiropyran moieties with photochromism properties.
- Protonated spiropyran ionogels exhibit a drastic swelling effect.
- Shrinking process of the ionogels happen upon white light irradiation.

Linear dimension change - 44%
Nitrite detection micro-fluidic device
Nitrite detection system

- **Emitter**
- **Detector**
- **Microchip**
- **Wireless Radio**
- **Chip Cradle (in house design)**
- **Battery**
- **Microcontroller board**
- **White LED for Valve actuation**

**Details:**
- Emitter: 540 nm
- Detector: 660 nm
- White LED: 540 nm
- Detector: 660 nm

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Nitrite detection system

Battery

Microcontroller board

Wireless Radio

Chip Cradle
(in house design)

Microfluidic Chip Cradle

Green LED (540nm)

White LED

Detector LED (660nm)
Method validation (off chip)

Concentration range of NO$_2$: 0.0 - 1.2
Method validation (off chip)
Centrifugal Disc System

- Low cost single use microfluidic device.
- Multiple samples analysis in a single microfluidic device.
- Multiplexing capabilities (pH, turbidity, nitrite,...).
- Portable system: sample analysis at the point of care.
- Wireless communication system.
Training & Outreach

Conferences

- **MicroTAS**, The 15th International Conference on Miniaturized Systems for Chemistry and Life Sciences, 2-6 Oct 2011, Seattle, USA (ORAL)
- **SPIE-2011**, Nanoscience + Engineering, 21 - 25 August, 2011, San Diego, California, USA, (INVITED TALK)

Anticipated conferences

- **Lab-on-a-Chip European Congress**, 27-28 March 2012, Edinburgh, Scotland (POSTER)
- **6th International Conference on Environmental Science and Technology 2012**, which will be held in June 25-29, Texas, USA (ORAL)
- **MicroTAS**, The 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, 31 Oct- 3 Nov 2012, Okinawa, Japan
Training & Outreach

Publications

• The Key to Revolutionary Breakthroughs in Micro-fluidic Devices, Proceedings SPIE 8107, 81070C, 2011; doi:10.1117/12.895330 (REVIEW PAPER)
• Integrating Stimulus-Responsive Materials and Microfluidics – The Key to Next Generation Chemical Sensors, JIMMS (in preparation)
• Novel optical sensing system based on wireless paired emitter detector diode device for Lab-on-a-Disc water quality measurements, Lab Chip (in preparation)

Personal Developement

• **Short course**: Lab-on-a-chip technologies for applications in the life sciences, Transducers 2011 Conference, 5-9 June 2011, Beijing, China.
• **Short course**: Microfluidics: Device Science and Technology; Transducers 2011 Conference, 5-9 June 2011, Beijing, China.
• Cambridge **Certificate in Advanced English English Course**
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