CLARITY

CLARITY
Centre for Sensor Web Technologies

Incorporation of Photochromic Spiropyran Compounds and Spiropyran Modified Substrates into Flow Micro-systems

Silvia Scarmagnani and **Zarah Walsh**

Fernando Benito Lopez, Conor Slater, Mirek Macka, Brett Paull and Dermot Diamond

RSC | Advancing the Chemical Sciences

Analytical Research Forum 2009

12-15 July, University of Kent

UNIVERSITY COLLEGE DUBLIN

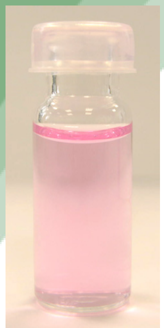
DUBLIN CITY UNIVERSITY

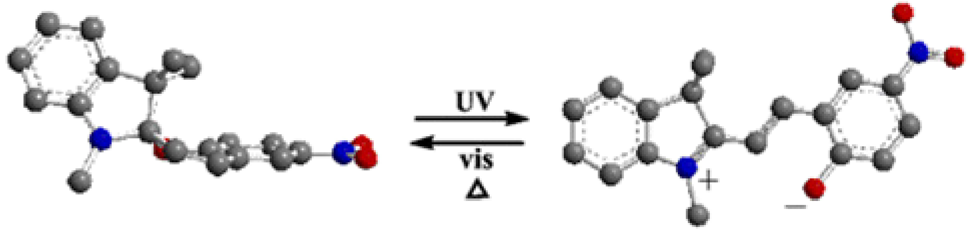
TYNDALL NATIONAL INSTITUTE

sfi science foundation ireland

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Photochromism of Spiropyran





SPIROPYRAN ***MEROCYANINE***

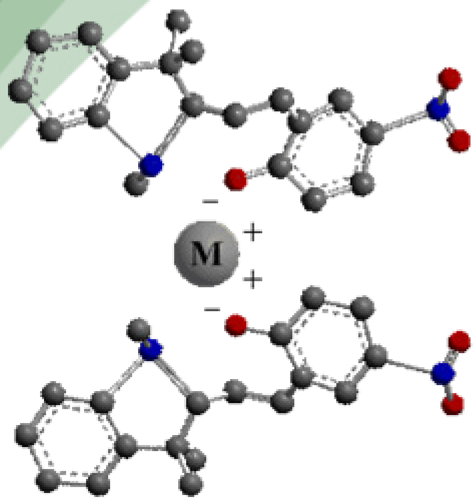
POLARITY → **Switchable electrosmotic nanoflow**

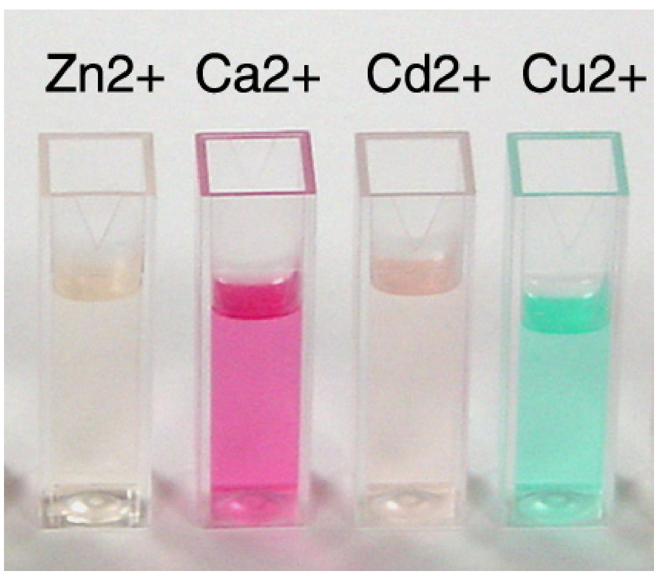
METAL BINDING → **Switchable metal binding stationary phases**

sfi science foundation ireland

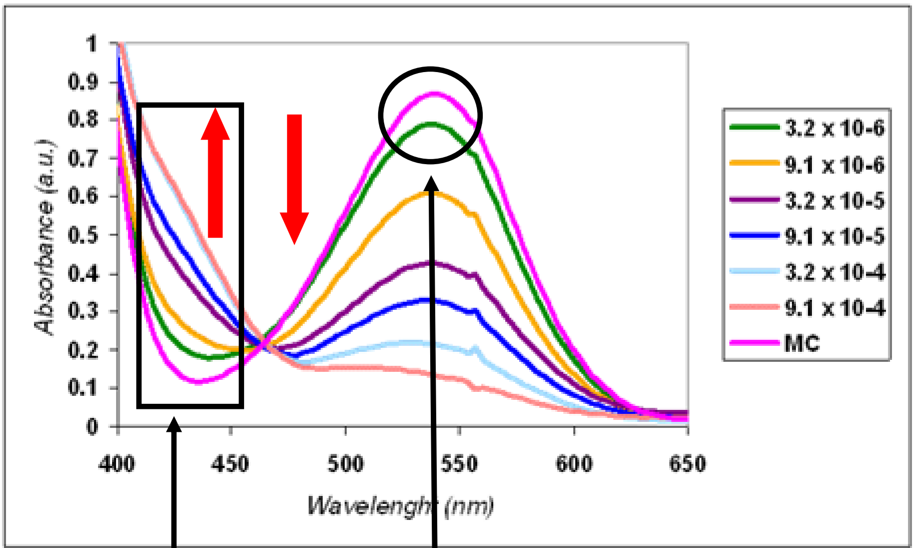
This work is supported by Science Foundation Ireland under grant 07/CE/I1147

MEROCYANINE SOLUTION STUDIES ON MELAT BINDING





Merocyanine – Cu^{2+}

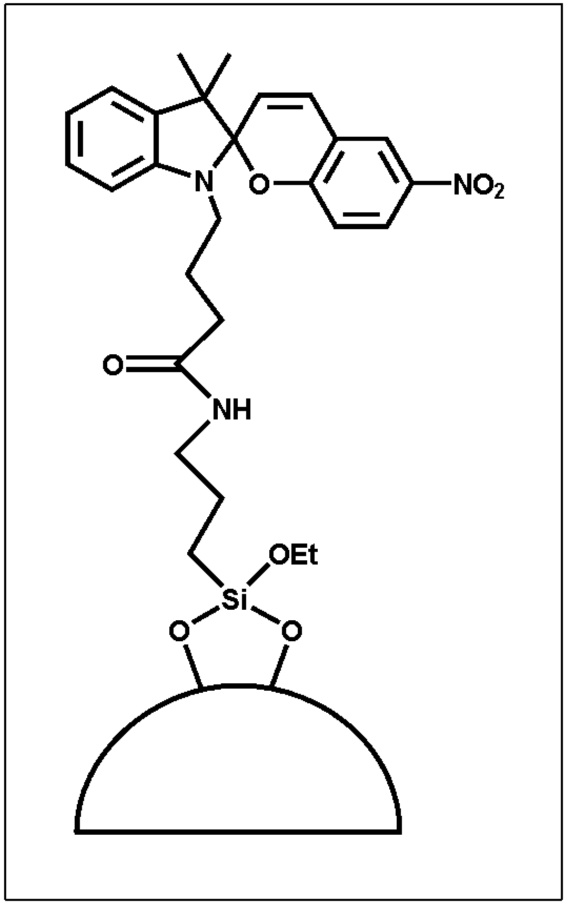


Decrease at 540 nm as free MC concentration decreases

Increase in absorbance below ~460 nm due to formation of MC-Cu^{2+} complex

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

SPIROPYRAN MODIFIED SILICA MICROBEADS



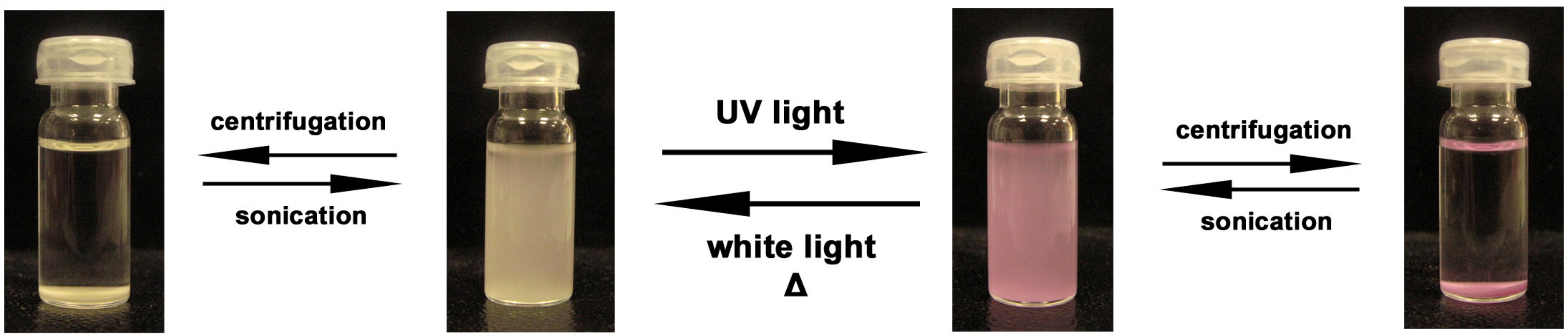
Spiropyran Microspheres Functionalisation:

- NH_2 functionalisation of the silica surface
- Spiropyran (SP-COOH derivative) attaching *via* EDC coupling

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

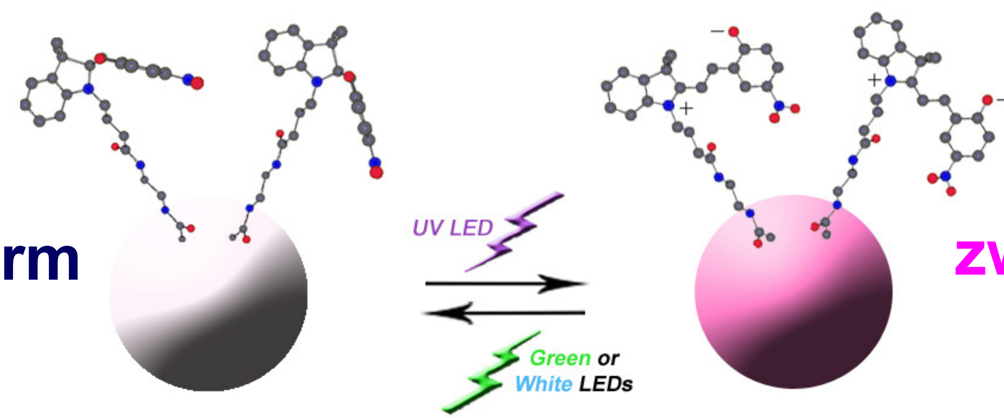
Silica Beads – Switching -

CLARITY
Centre for Sensor Web Technologies



switching between

WHITE
spiro
uncharged form



PINK
mero
zwitterionic form

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

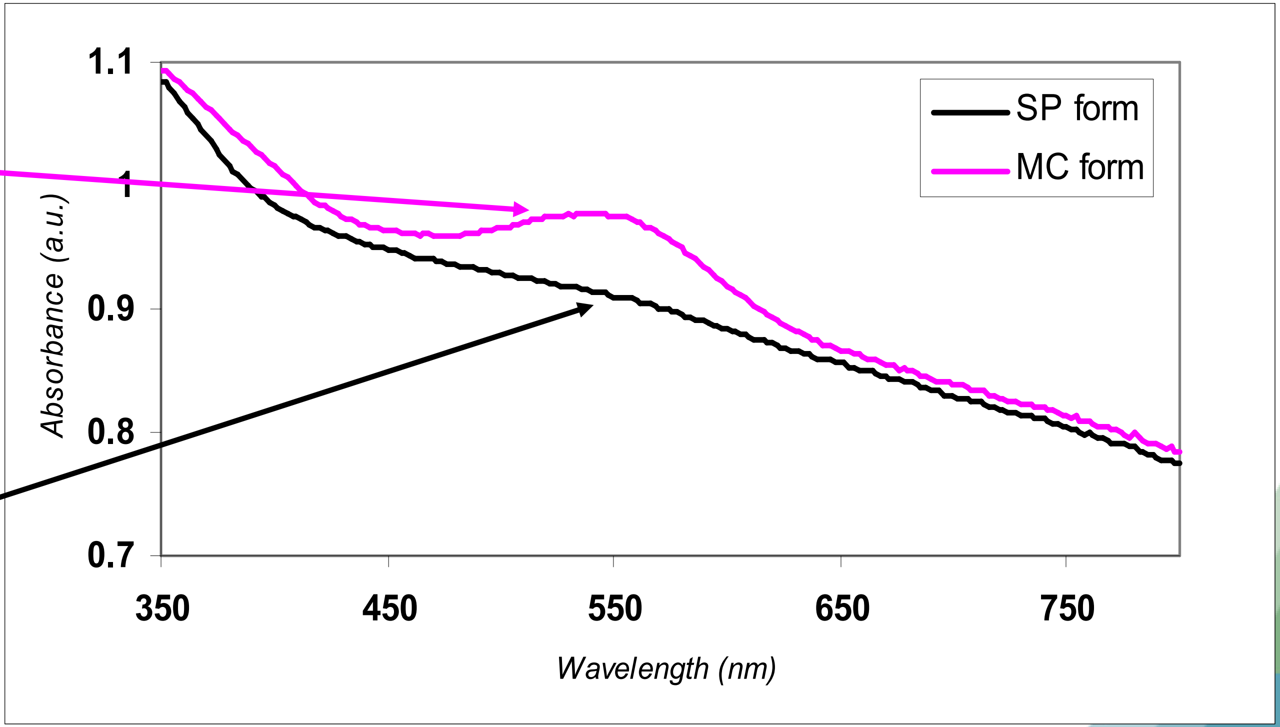
UNIVERSITY COLLEGE DUBLIN
DUBLIN CITY UNIVERSITY
TYNDALL NATIONAL INSTITUTE

Spiropyran Switching on the Silica Bead

Silica MC λ_{max}= 558 nm (EtOH suspension)

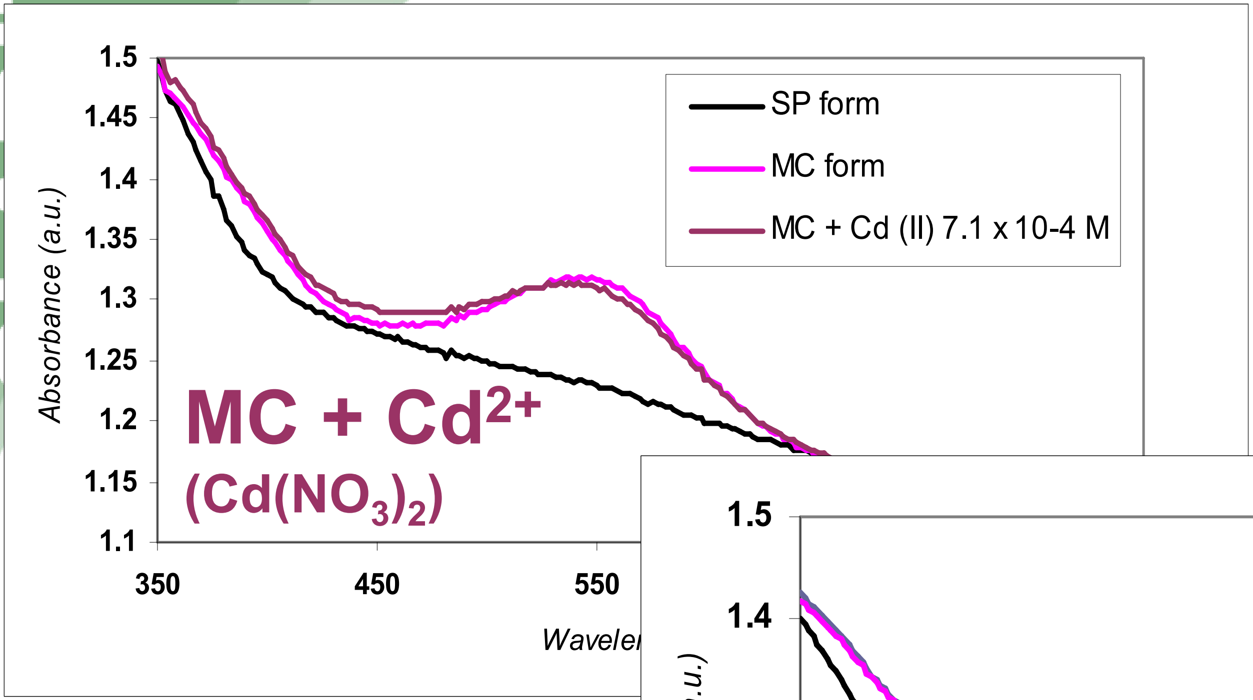
MC: 375 nm LED irradiation

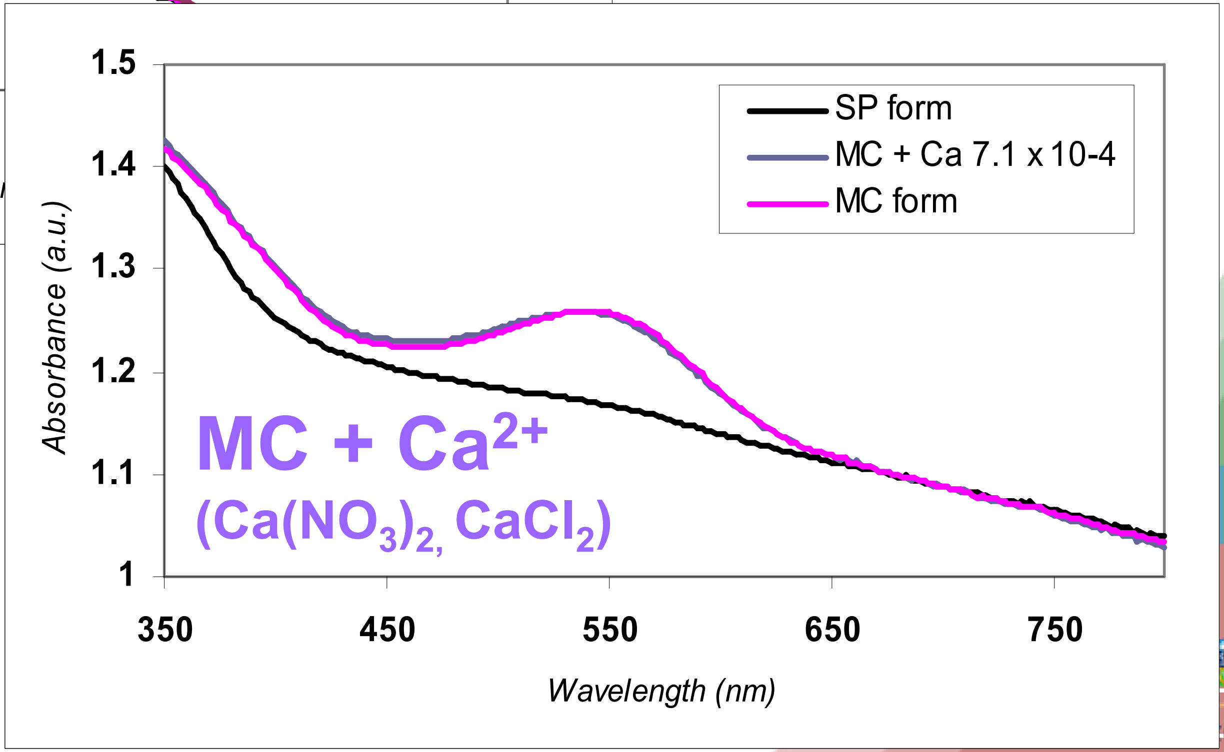
SP: 430-760 nm white LED irradiation



This work is supported by Science Foundation Ireland under grant 07/CE/I1147

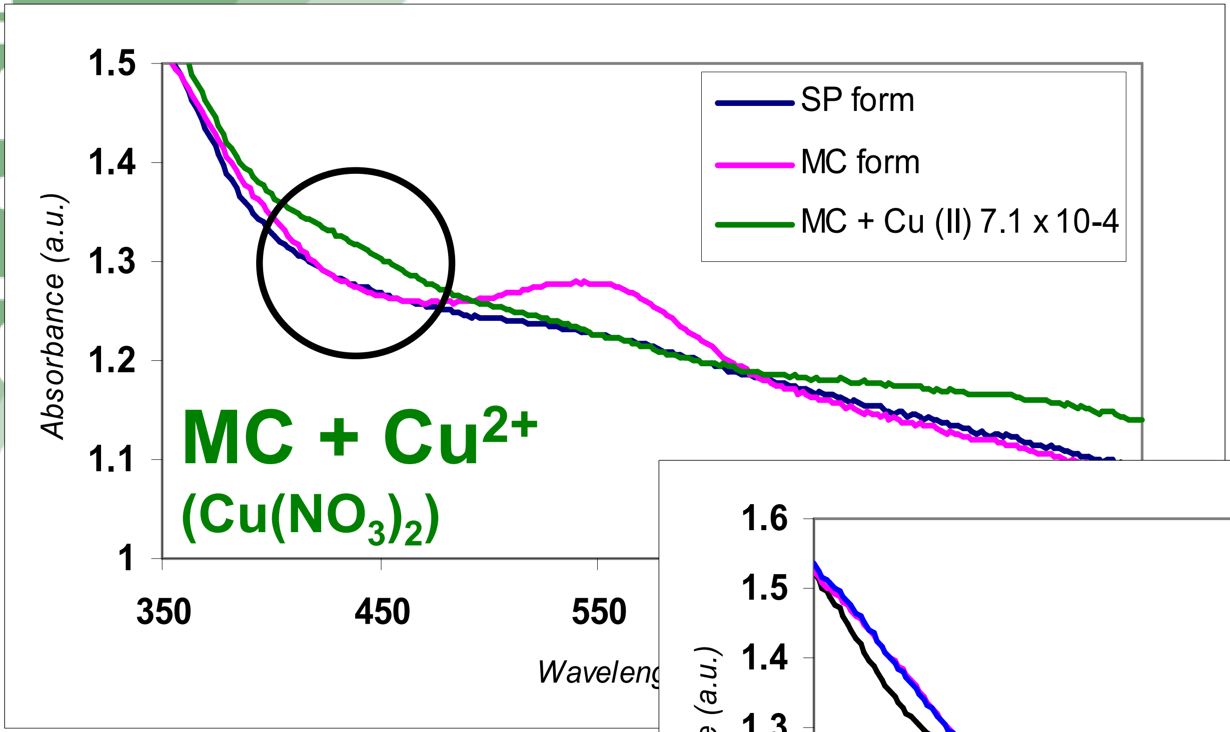
Beads in the presence of Metal Ions

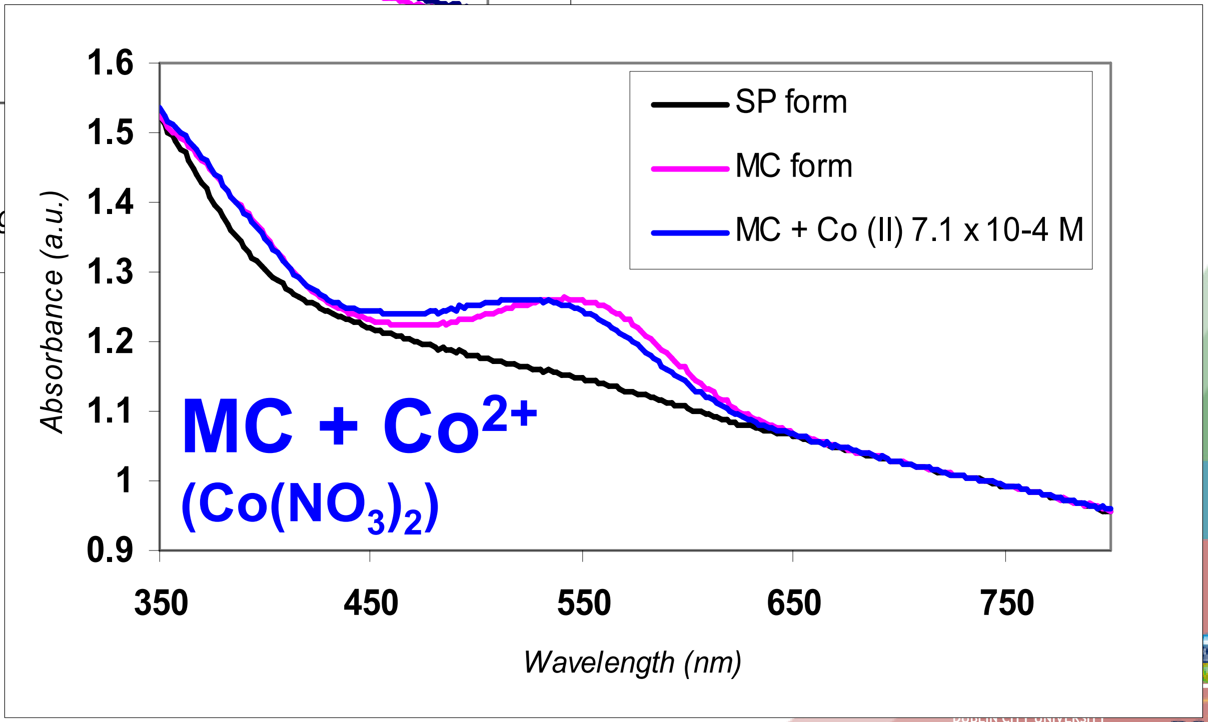




This work is supported by Science Foundation Ireland under grant 07/CE/I1147

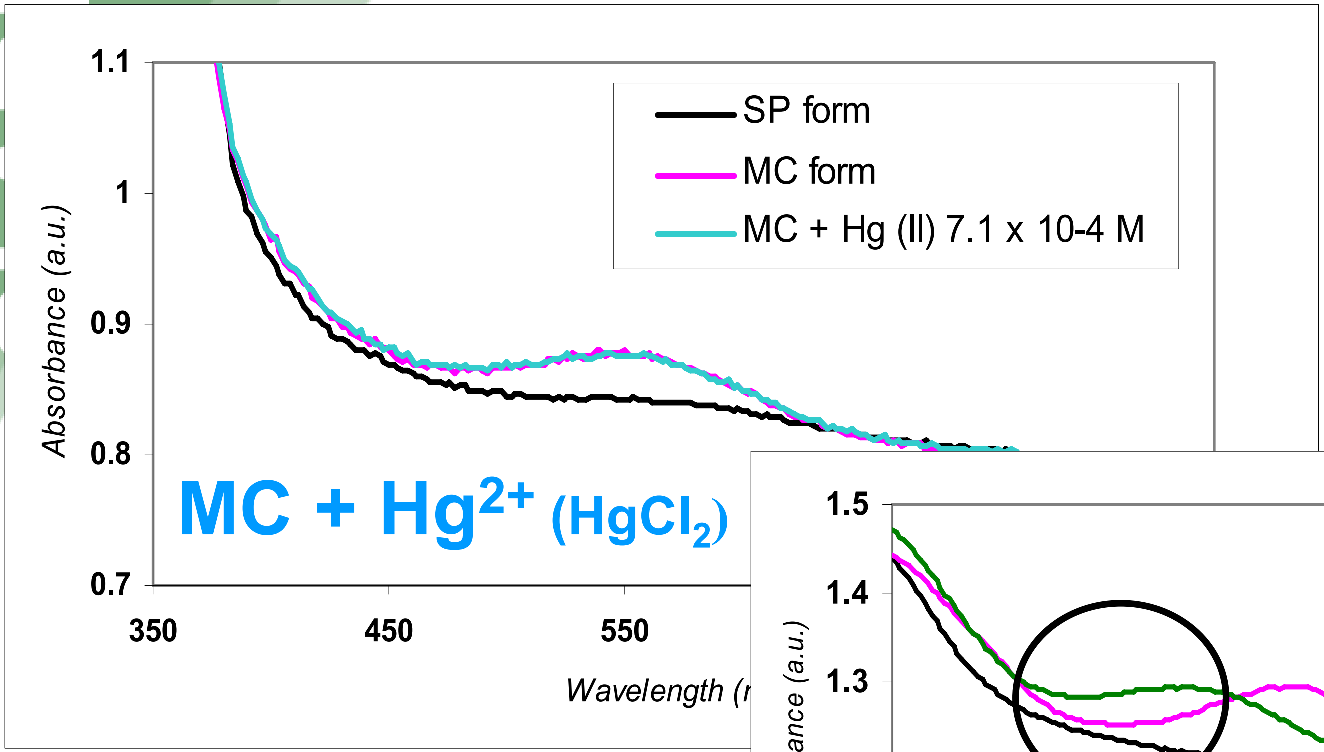
Beads in the presence of Metal Ions

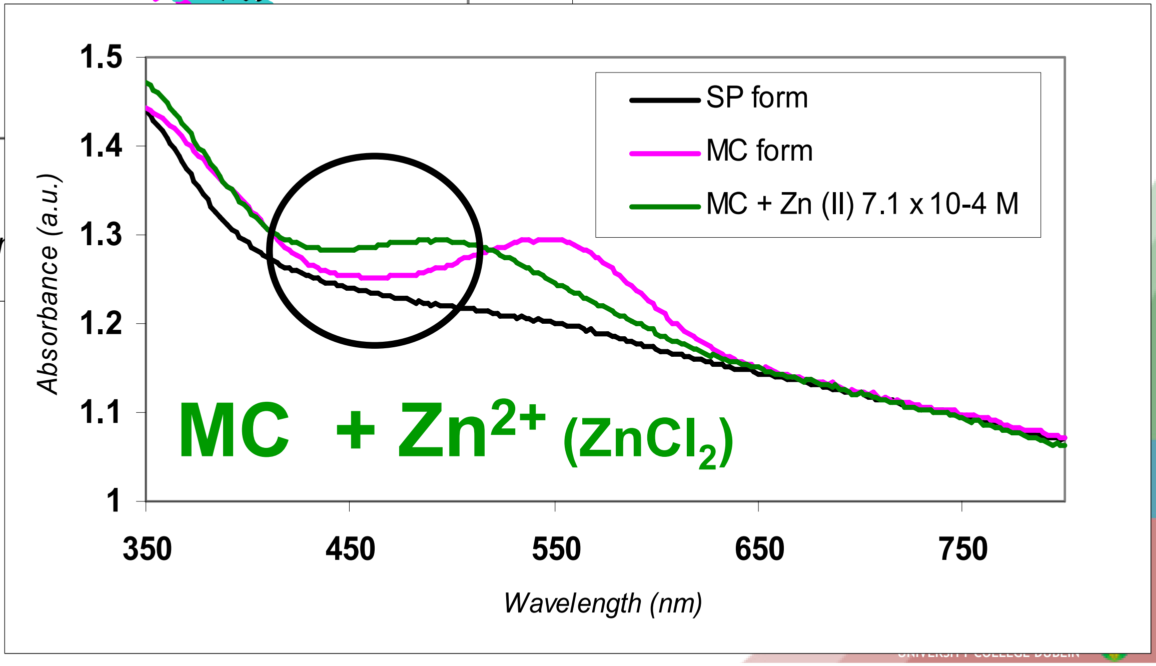




This work is supported by Science Foundation Ireland under grant 07/CE/I1147

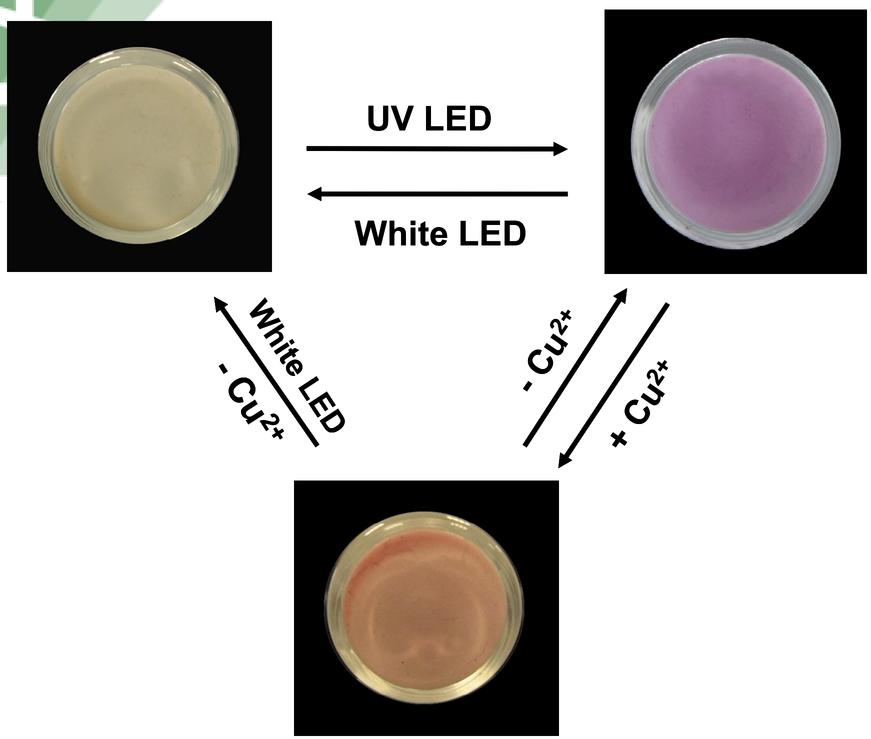
Beads in the presence of Metal Ions



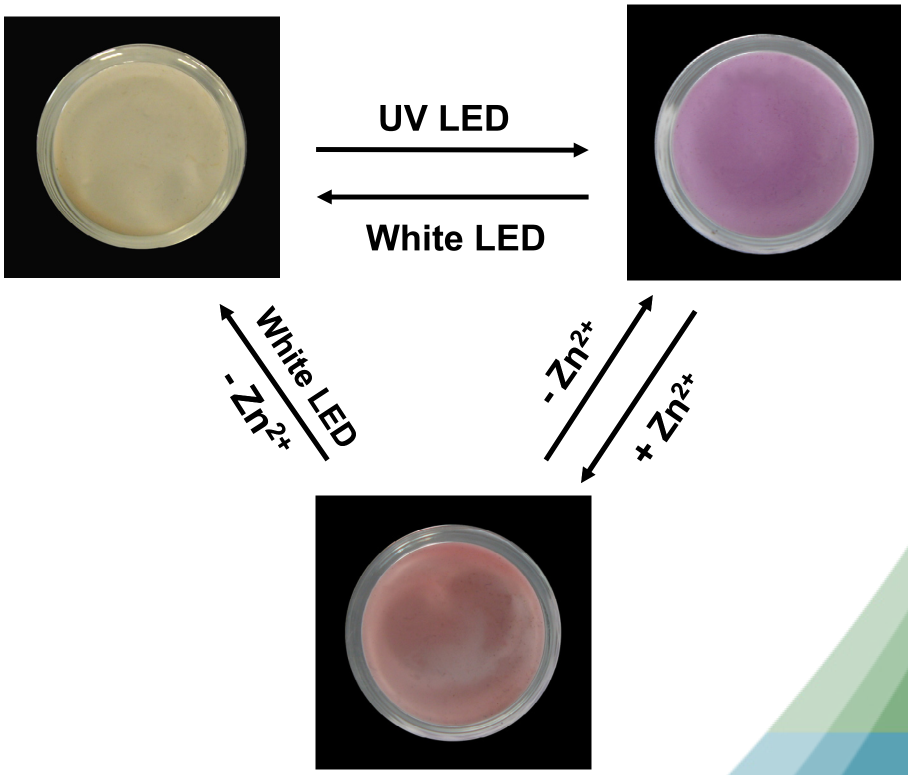


This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Colour change in the presence of Cu^{2+} and Zn^{2+}



MC + Cu^{2+} ($Cu(NO_3)_2$)



MC + Zn^{2+} ($ZnCl_2$)

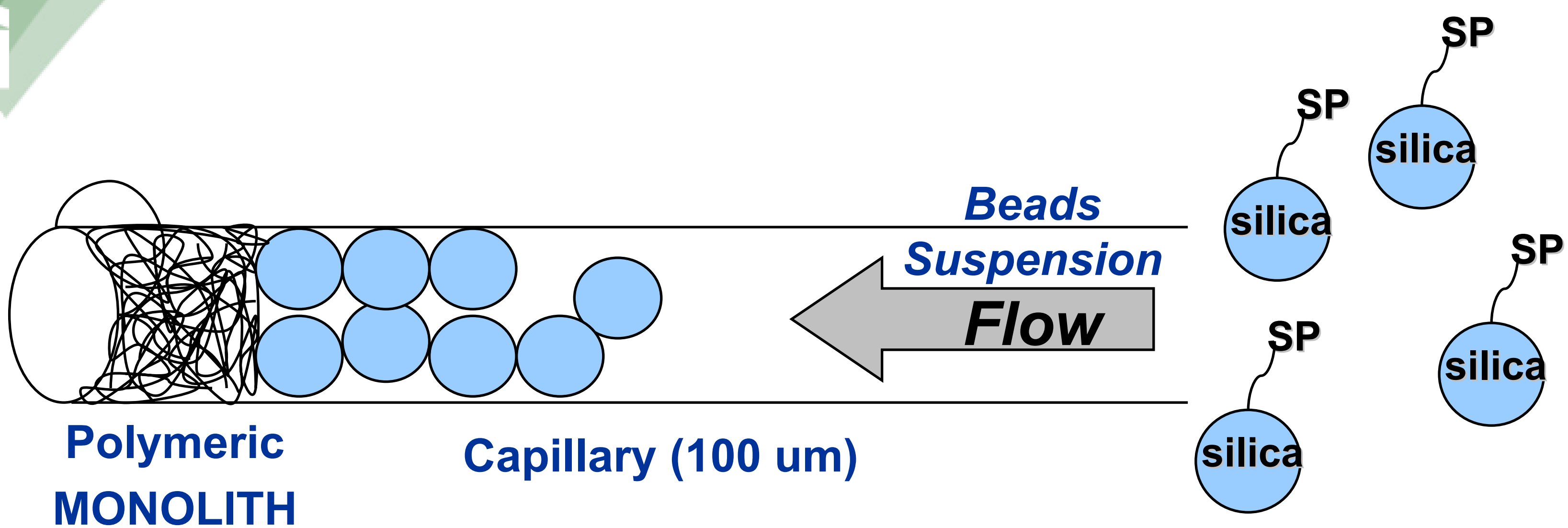
This work is supported by Science Foundation Ireland under grant 07/CE/I1147

CLARITY
Centre for Sensor Web Technologies
UNIVERSITY COLLEGE DUBLIN
DUBLIN CITY UNIVERSITY
TYNDALL NATIONAL INSTITUTE

CLARITY
CENTRE FOR SENSOR WEB TECHNOLOGIES

SILICA SPIROPYRAN-modified MICROBEADS

- CAPILLARY PACKING -



Polymeric
MONOLITH

Capillary (100 um)

Pore Size : 1-2um

Butyl methacrylate (BuMA)

ethylene dimethacrylate (EDMA)

5 um Silica microbeads
Spiropyran functionalised

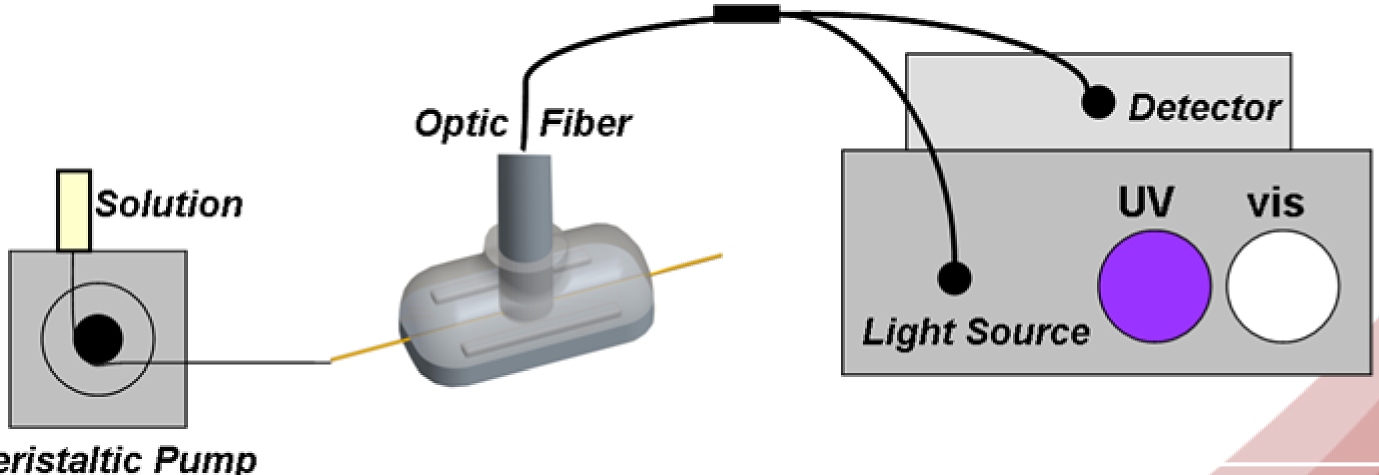
This work is supported by Science Foundation Ireland under grant 07/CE/I1147

UNIVERSITY COLLEGE DUBLIN
DUBLIN CITY UNIVERSITY
TYNDALL NATIONAL INSTITUTE

SILICA SPIROPYRAN-modified MICROBEADS

Capillary REFLECTANCE DETECTION

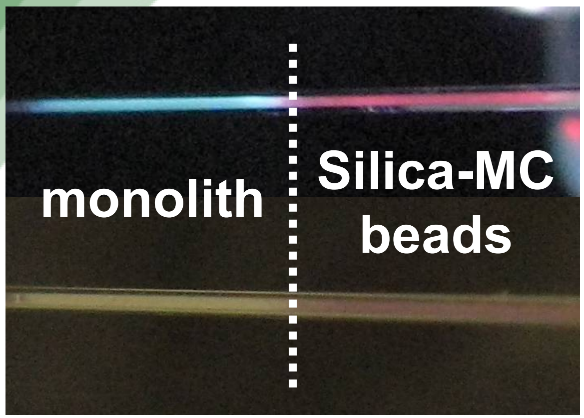
- Capillary **FLUSHING** with ethanolic solution for 30 min
- **IRRADIATION** with **vis-light** for 3 minutes **(beads in the SP form)**
- **REFLECTANCE** recording
- **IRRADIATION** with **UV-light** for 3 minutes **(beads in the MC or MC+Me form)**
- **REFLECTANCE** recording



This work is supported by Science Foundation Ireland under grant 07/CE/I1147

SILICA SPIROPYRAN-modified MICROBEADS

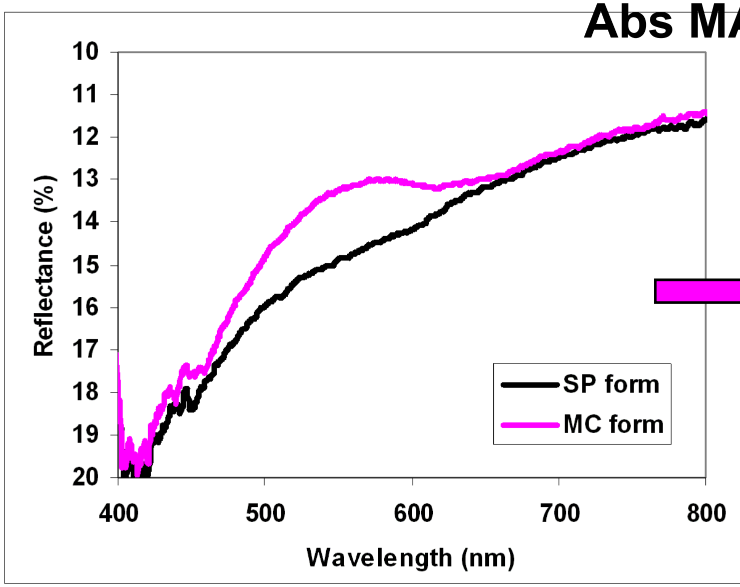
- SWITCHING -

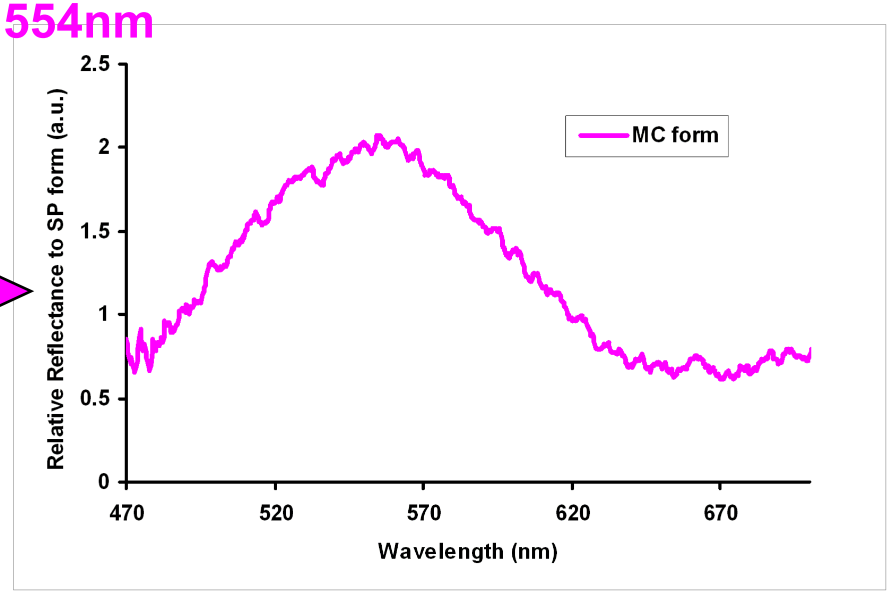


under UV irradiation

after removal of the light source

Abs MAX: 554nm



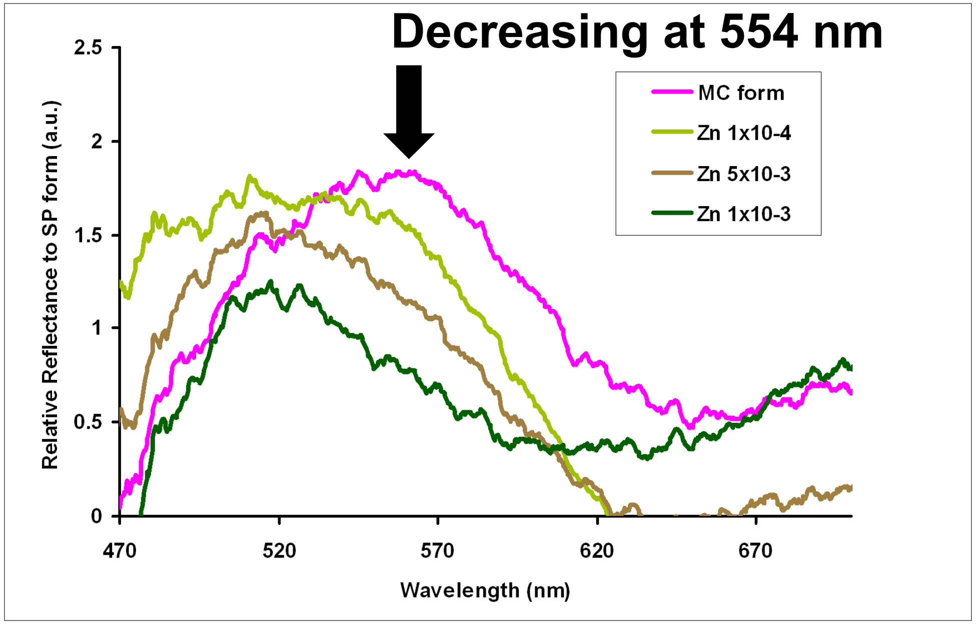


This work is supported by Science Foundation Ireland under grant 07/CE/I1147

TYNDALL NATIONAL INSTITUTE

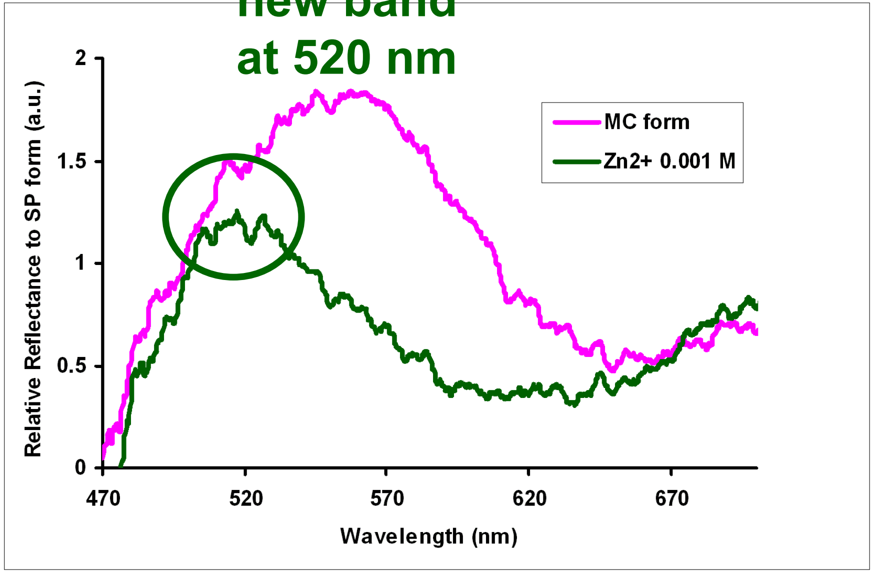
SILICA SPIROPYRAN-modified MICROBEADS

- METAL DETECTION -



Zn^{2+}

new band at 520 nm

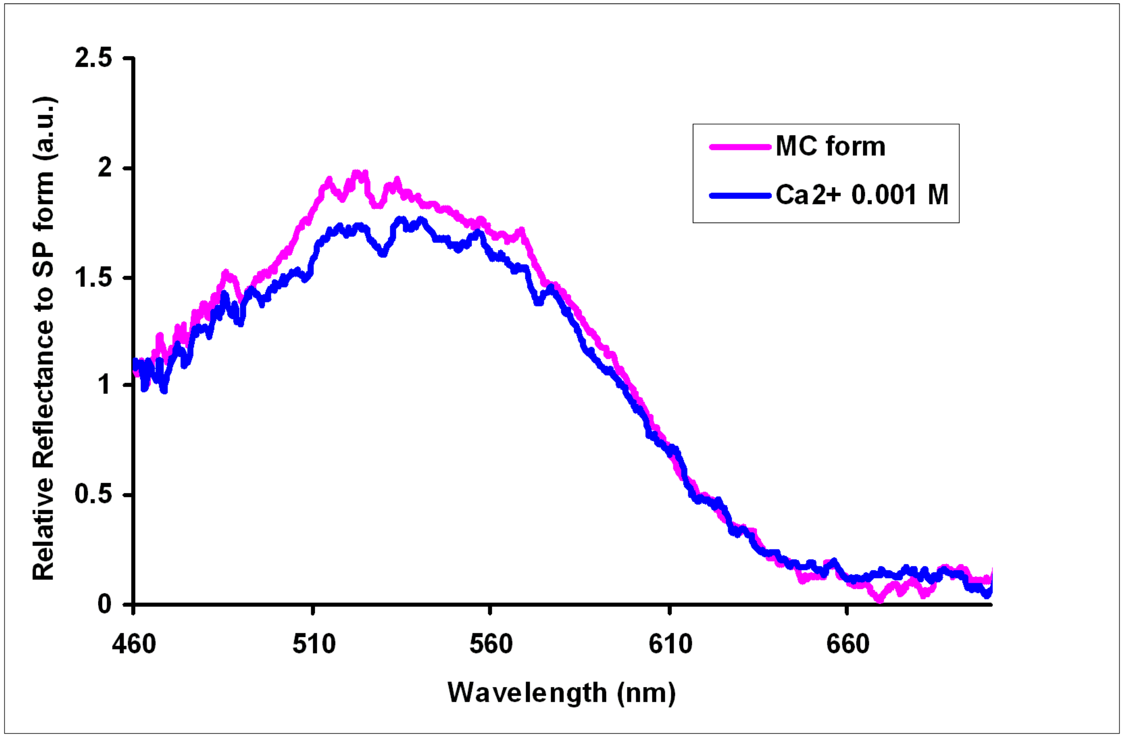


This work is supported by Science Foundation Ireland under grant 07/CE/I1147

SILICA SPIROPYRAN-modified MICROBEADS

- METAL DETECTION -

Ca^{2+} NO SPECTRAL CHANGE



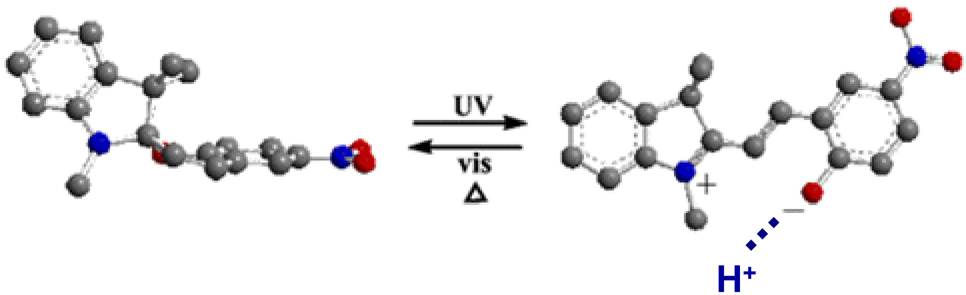
CLARITY
CENTRE FOR SENSOR WEB TECHNOLOGIES

UNIVERSITY COLLEGE DUBLIN
DUBLIN CITY UNIVERSITY
TYNDALL NATIONAL INSTITUTE

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Switchable Electrosmotic Nanoflow
- Spiropyran Monolithic stationary phase -

Zarah Walsh

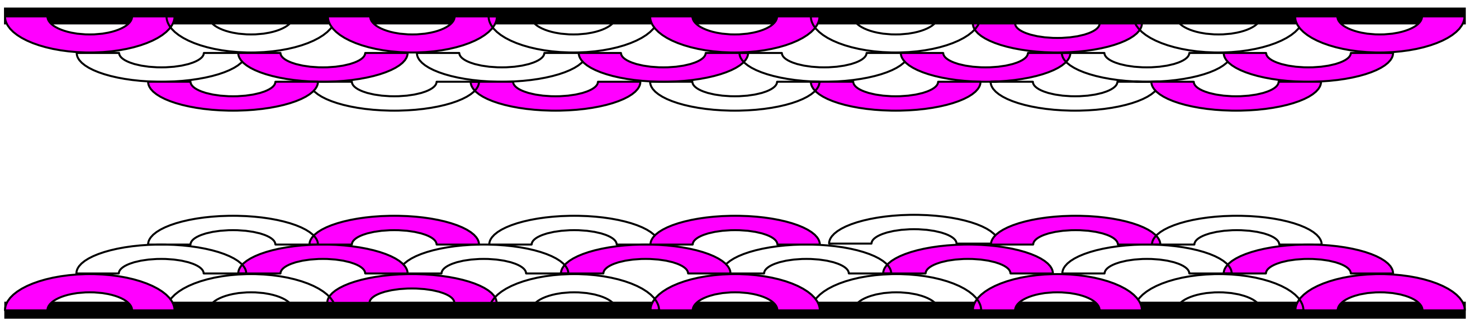


- Possibility of protonation of the merocyanine form
- Strong change in the surface polarity
- Light switchable electrosmotic nanoflow

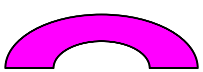
This work is supported by Science Foundation Ireland under grant 07/CE/I1147

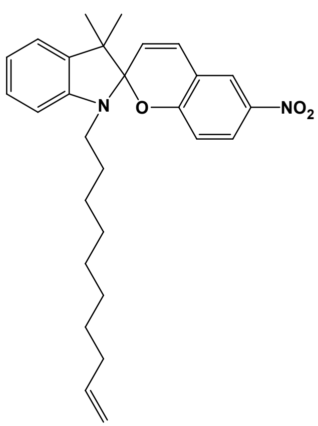
Switchable Electrosmotic Nanoflow
- Spiropyran Monolithic stationary phase -

SP-*co*-DVB



 **= DVB monomer (divinylbenzene)**

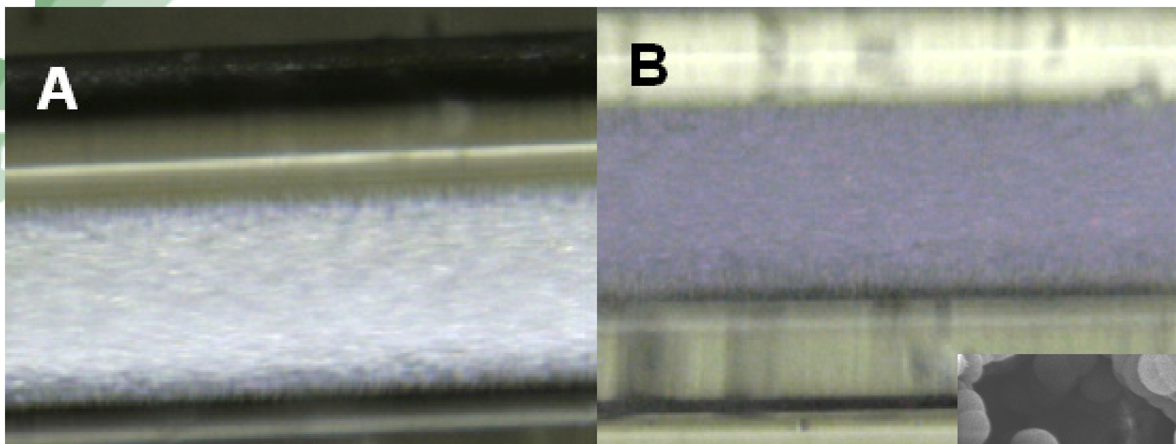
 **= SP monomer**



Thermal polymerisation
60 º C for 5 days

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

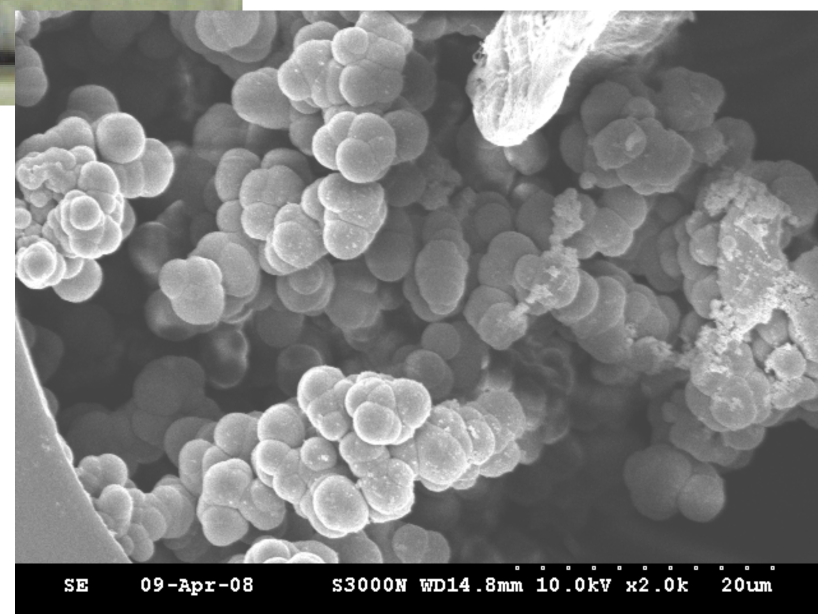
SP-DVB Monolith imaging Microscopy and SEM analysis



SP form

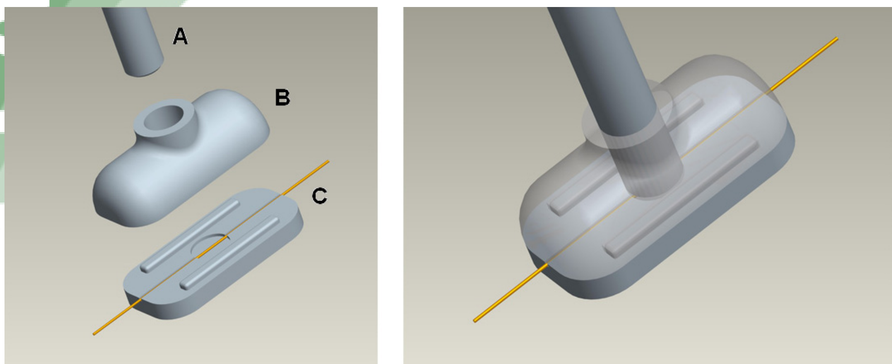
MC form

SEM image of the spiropyran monolith



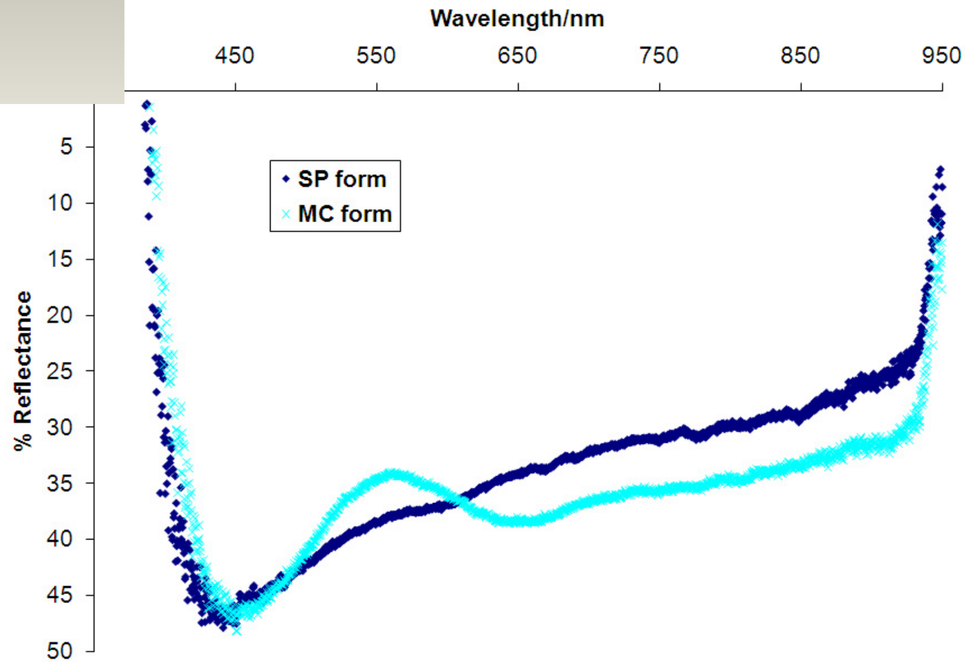
This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Reflectance measurment of UV-vis changes due to spiropyran-merocyanine conversion



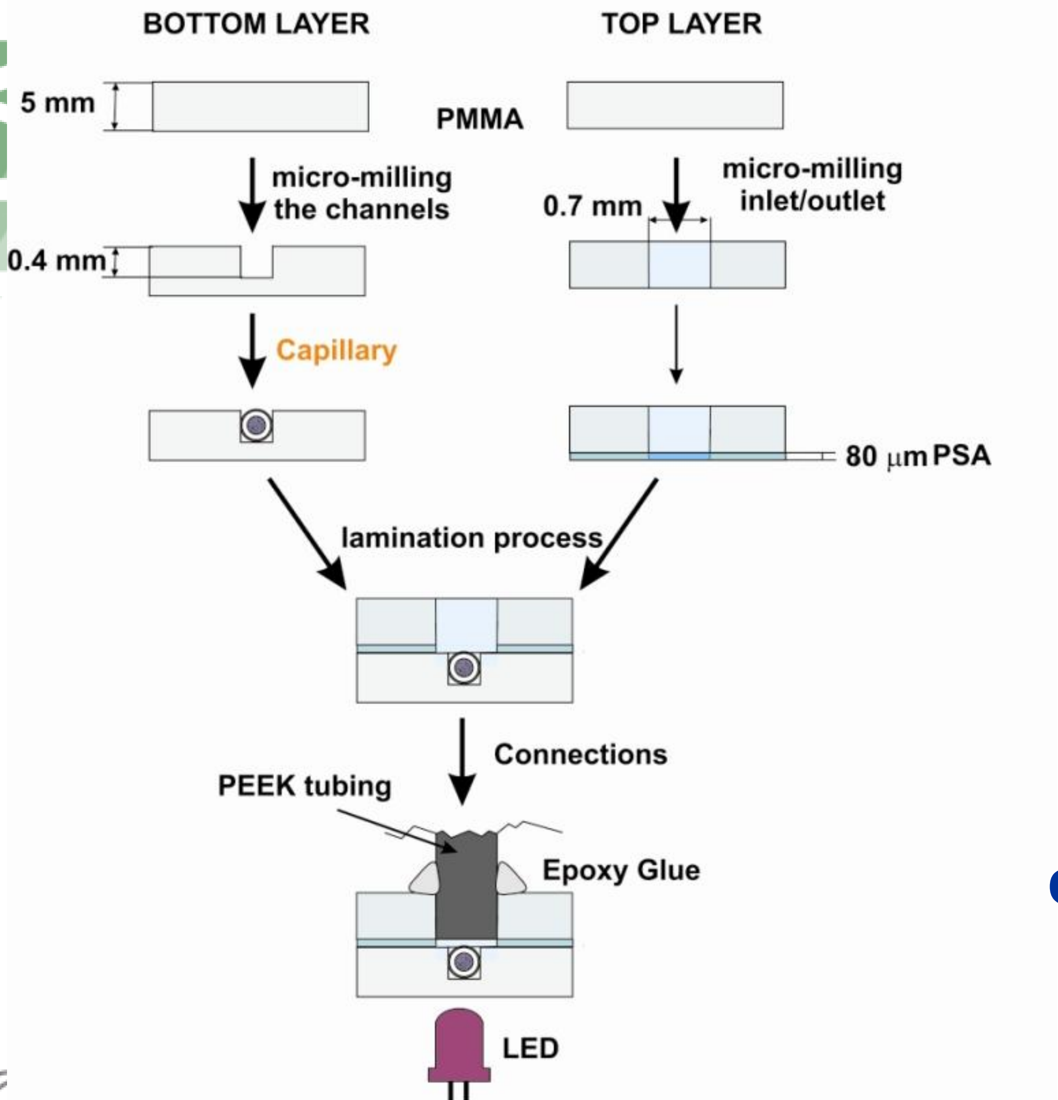
Reflectance set-up

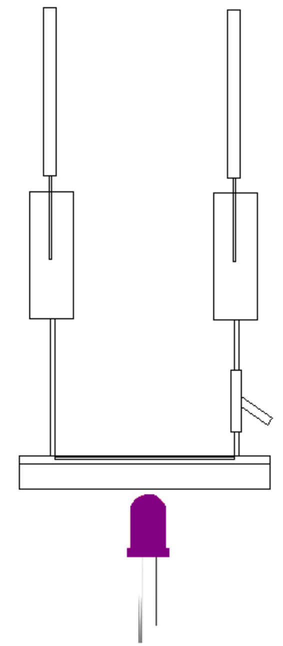
Reflectance measurements of the SP and the MC form of the SP-DVB during ethanol flushing



This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Light-Tunable Electrosmotic Nanoflow
Experimantal set-up

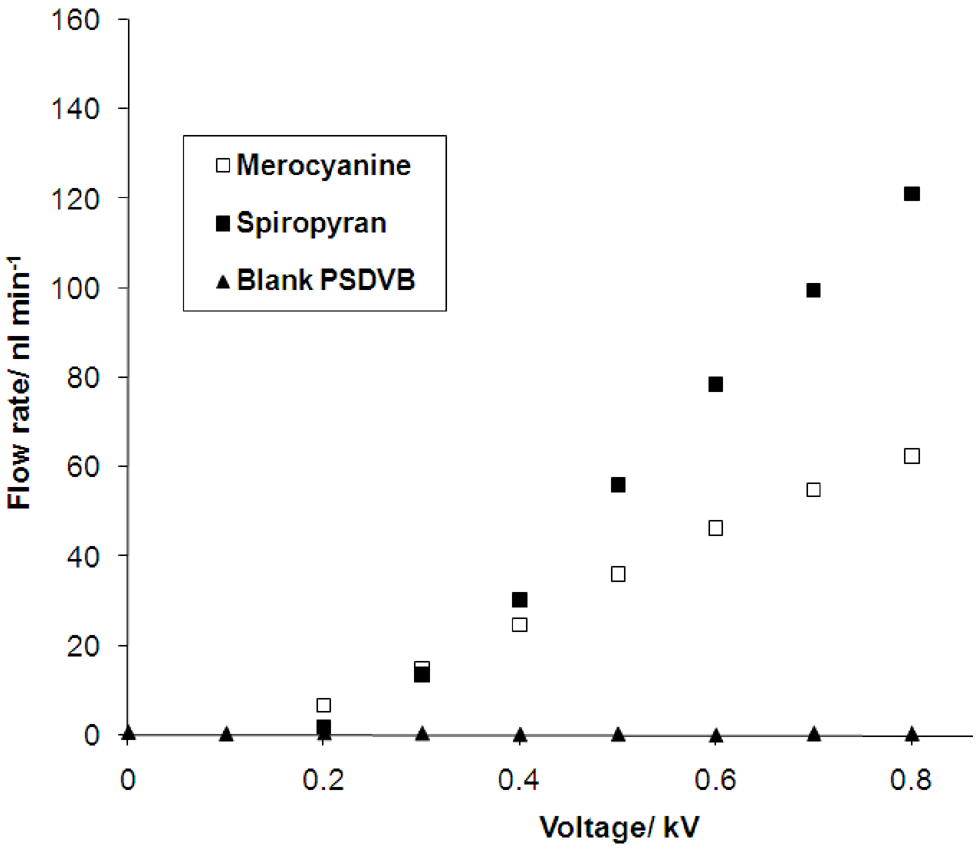




Constant Irradiation during the measurment using LEDs

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Light-Tunable Electrosmotic Nanoflow



- HCl solution 1mM
- 7 increasing applied voltage steps were measured
- Light tunable SP-DVB monolith compared to DVB without SP

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

UNIVERSITY COLLEGE DUBLIN
DUBLIN CITY UNIVERSITY
TYNDALL NATIONAL INSTITUTE

Future Direction

Incorporation of the light-induced reversible metal binding effect and tunable EOF pump on a microchip device

This work is supported by Science Foundation Ireland under grant 07/CE/I1147

Acknowledgements

CLARITY
CENTRE FOR SENSOR WEB TECHNOLOGIES

People

- Prof. Dermot Diamond, Prof. Brett Paull, Dr. Mirek Macka
- Zarah Walsh, Dr.Fernando Benito Lopez,

Dr. Nameer Alhashimy, Conor Slater, Dr. Robert Byrne

- Clarity group

Funding Sources

- Science Foundation Ireland

SFI 03/IN3/1361,07/CE/I1147, 07/RPF/MASF812

- Marie Curie Excellence Grant and Funding (MEXT-CT-2004-014361)

sfi science foundation ireland

This work is supported by Science Foundation Ireland under grant 07/CE/I1147