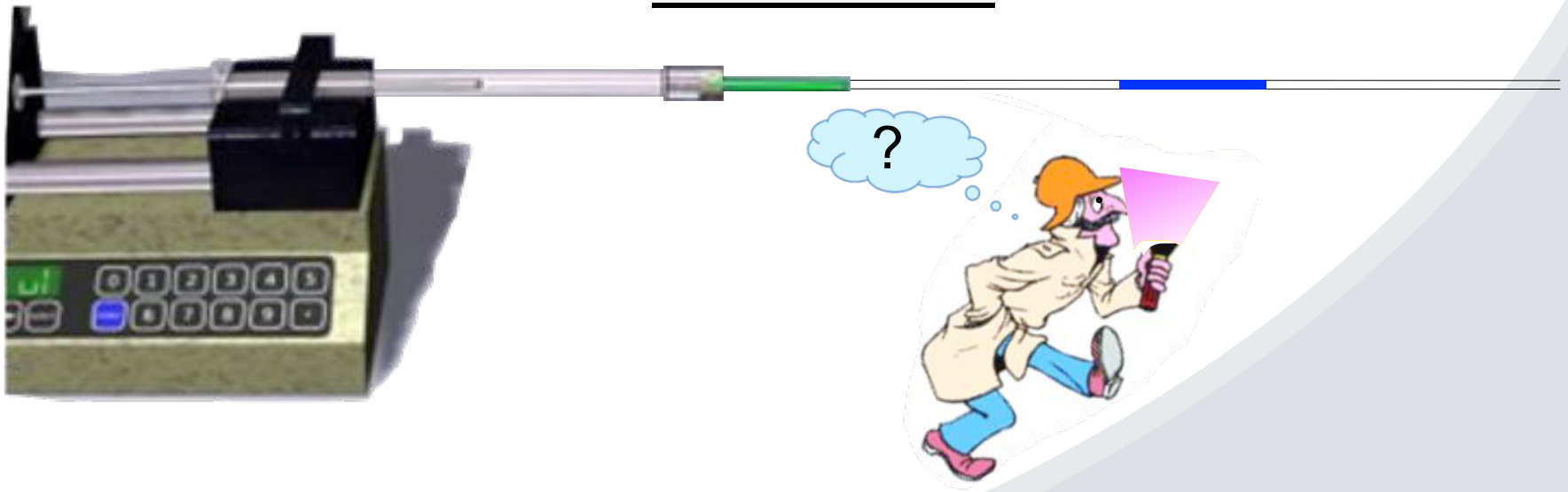
Spiropyran Modified Micro-capillaries as Photonically Controlled Self-indicating Systems For Metal Ion Accumulation and Release

Larisa Florea



November 2011

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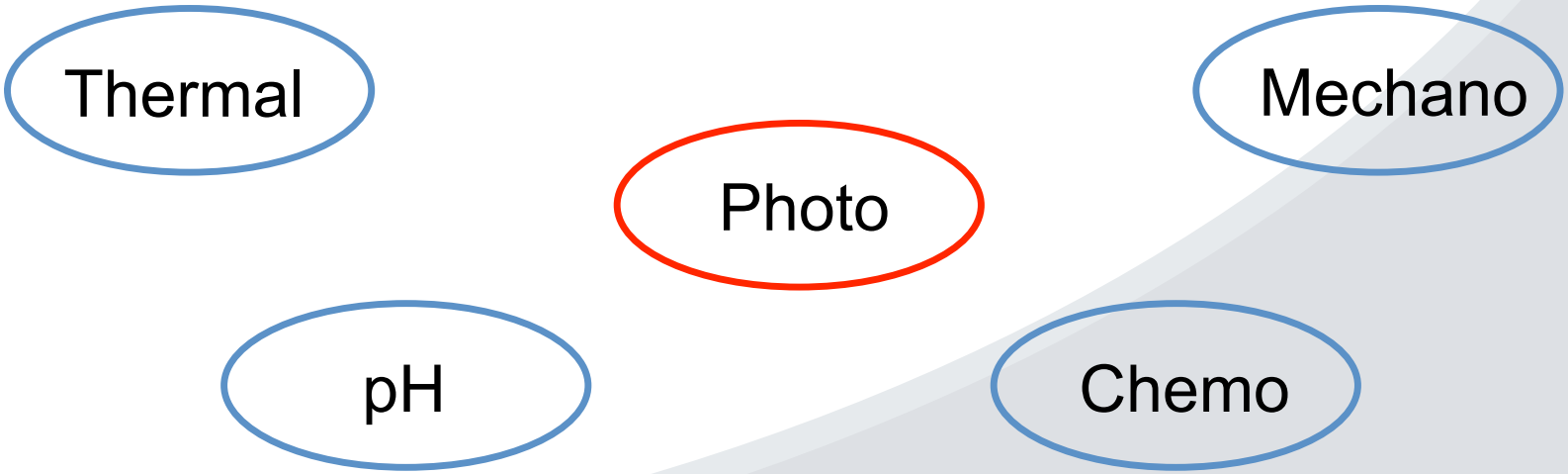
Outline

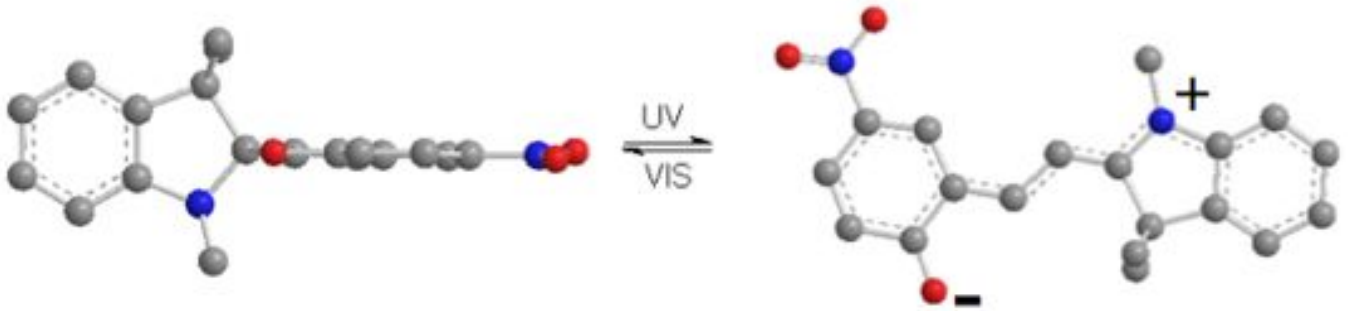
- Background
- Spiropyran based monomer
- Spiropyran polymeric brushes in micro-capillaries
- Metal ion detection, accumulation and release
- Conclusions

Stimuli-responsive Materials

Materials whose characteristics can be changed using an external stimulus

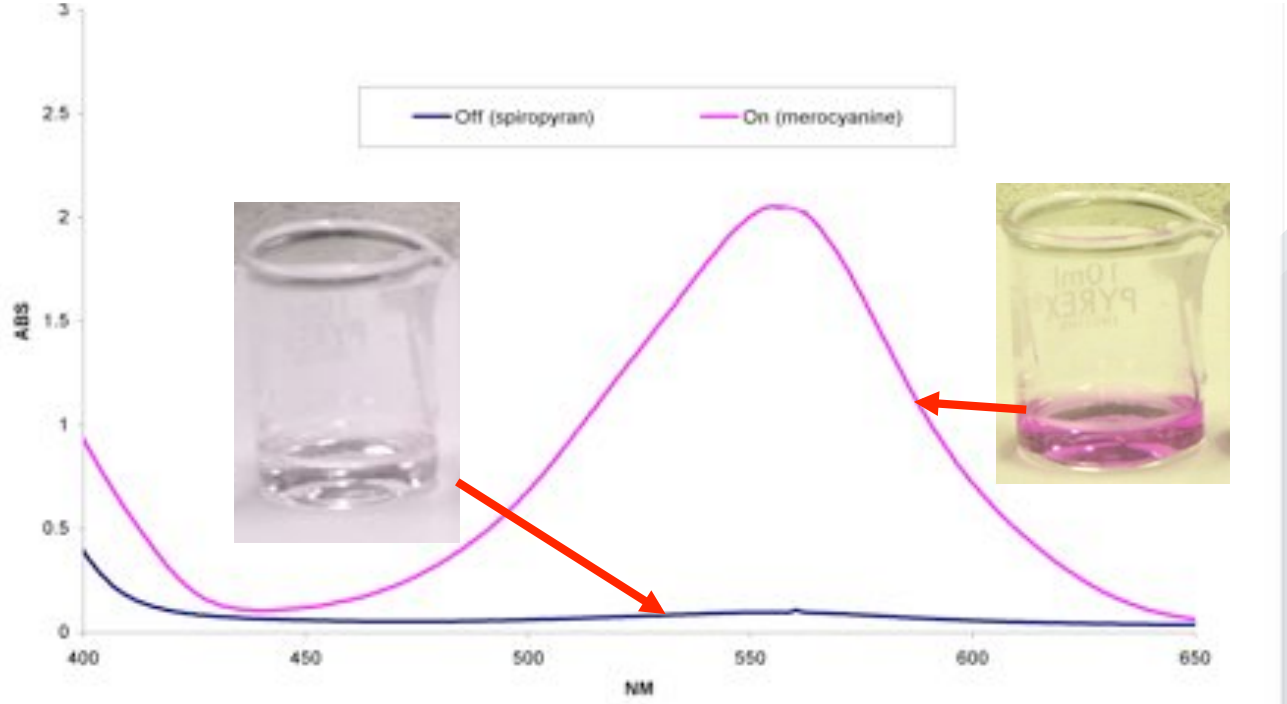


Spiropyran

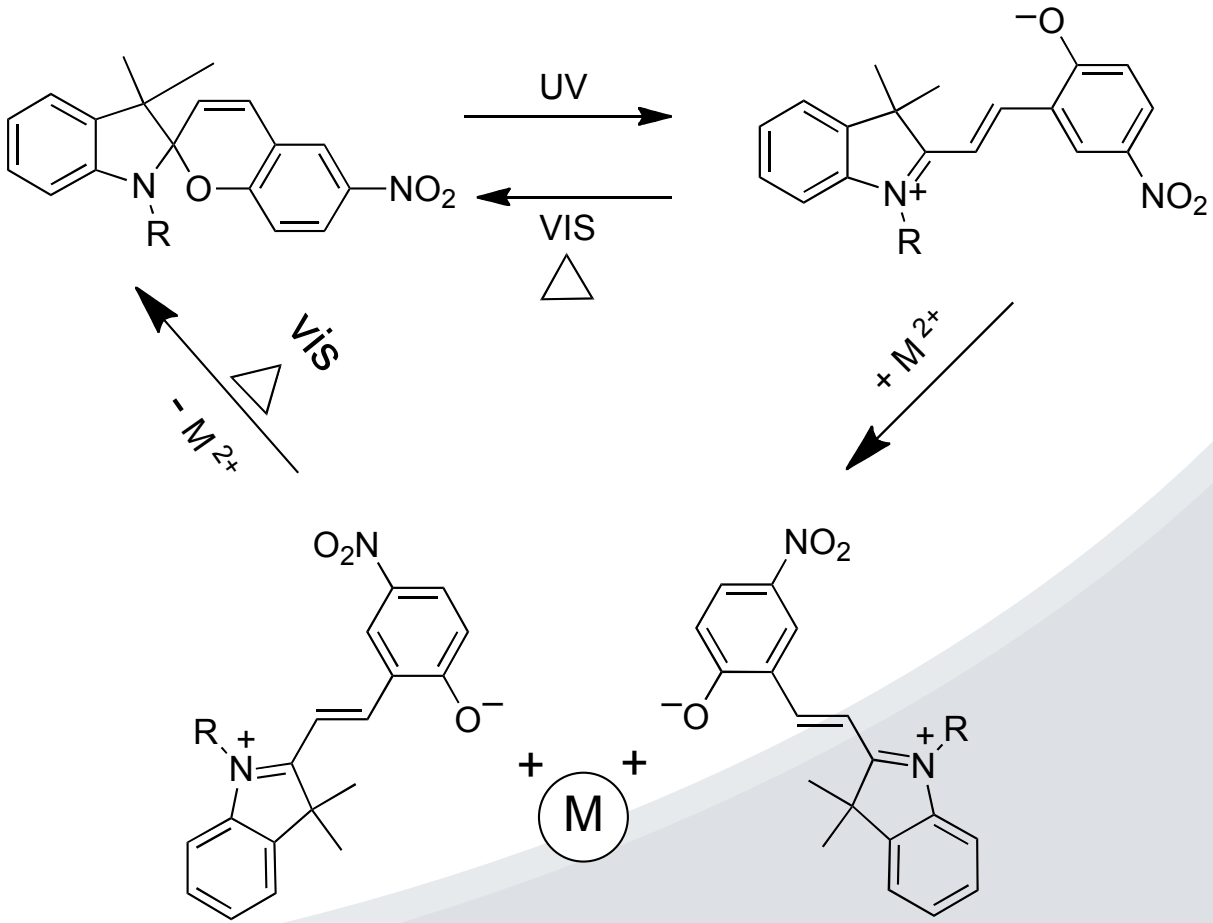


Spiropyran SP (closed, colorless)

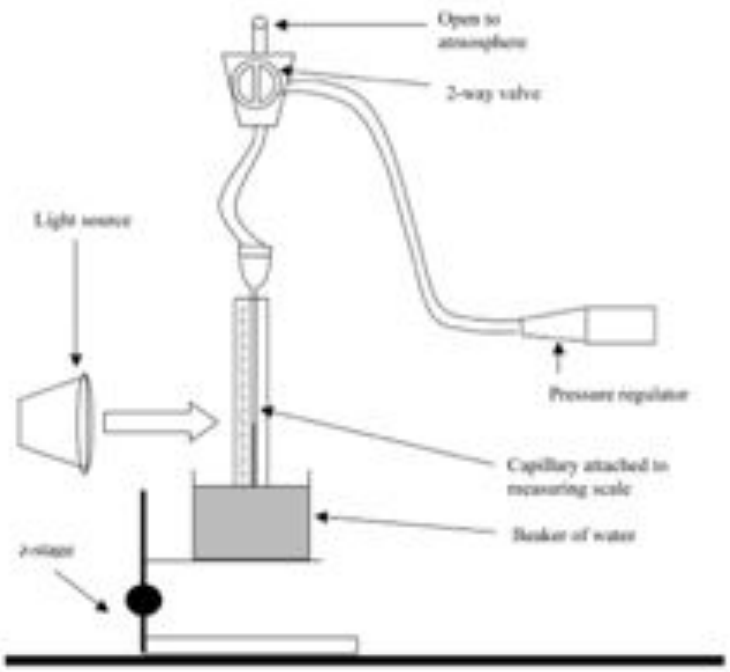
Merocyanine MC (open, colored)



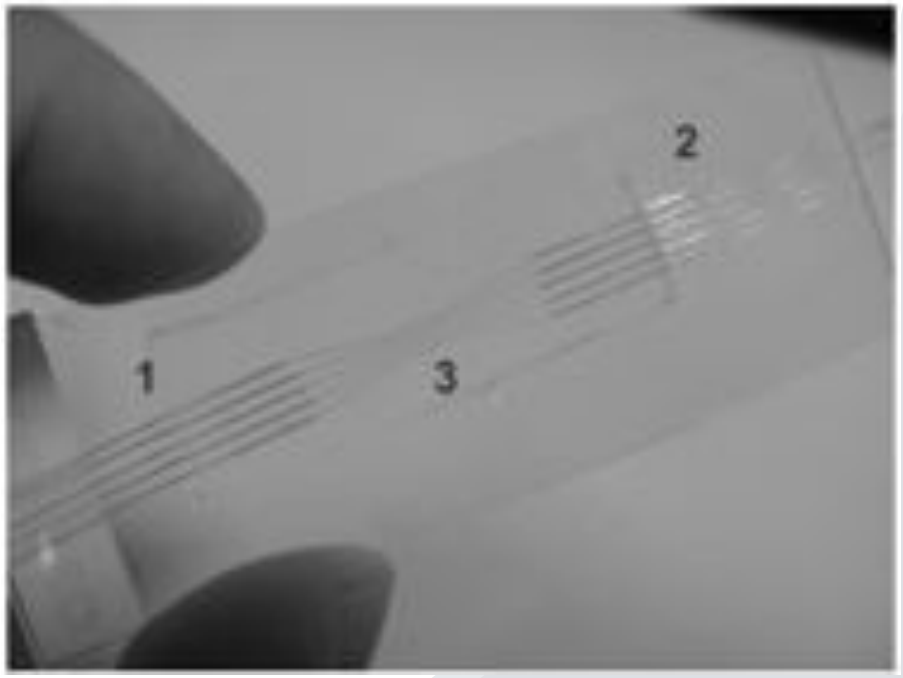
Metal Ion Binding Proprieties



Common Approach - Monolayer



Experimental setup for measurement of capillary rise in a spiropyran monolayer functionalised capillary [1].



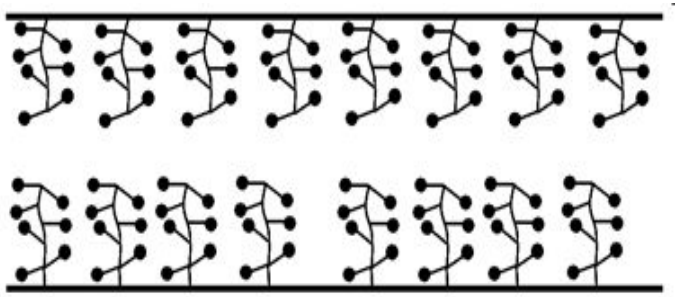
PDMS/glass hybrid micro-fluidic device functionalised with a monolayer of spiropyran molecules [2].

Low loading of spiropyran molecule

[1] R. Rosario *et al.* / Langmuir, 18 (2002) 8062-8069

[2] F. Benito-Lopez *et al.* / Sensors and Actuators B 140 (2009) 295–303

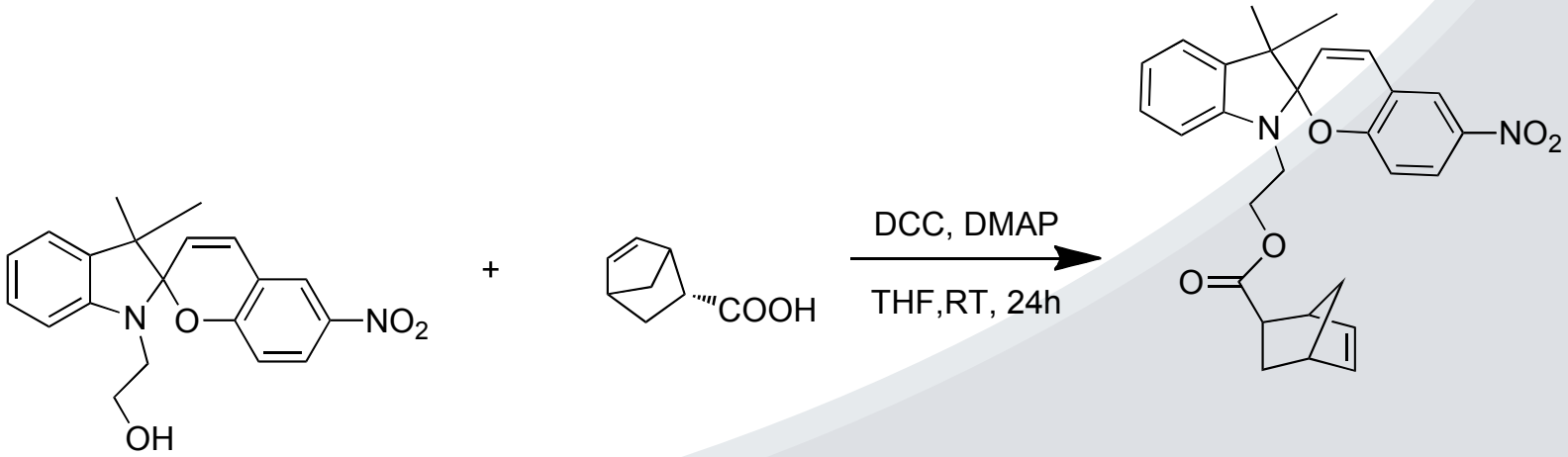
Our Approach



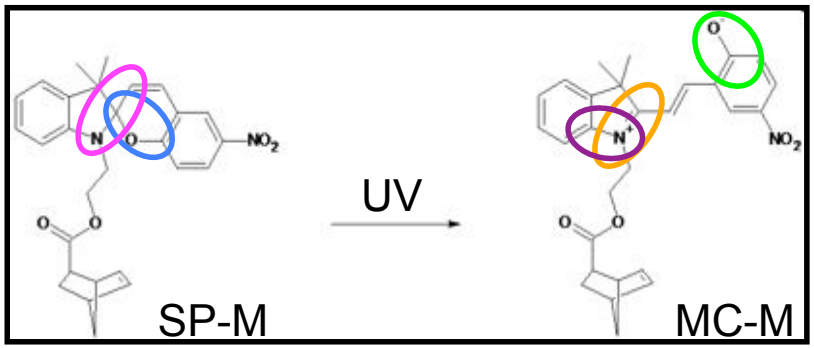
- spiropyran molecule

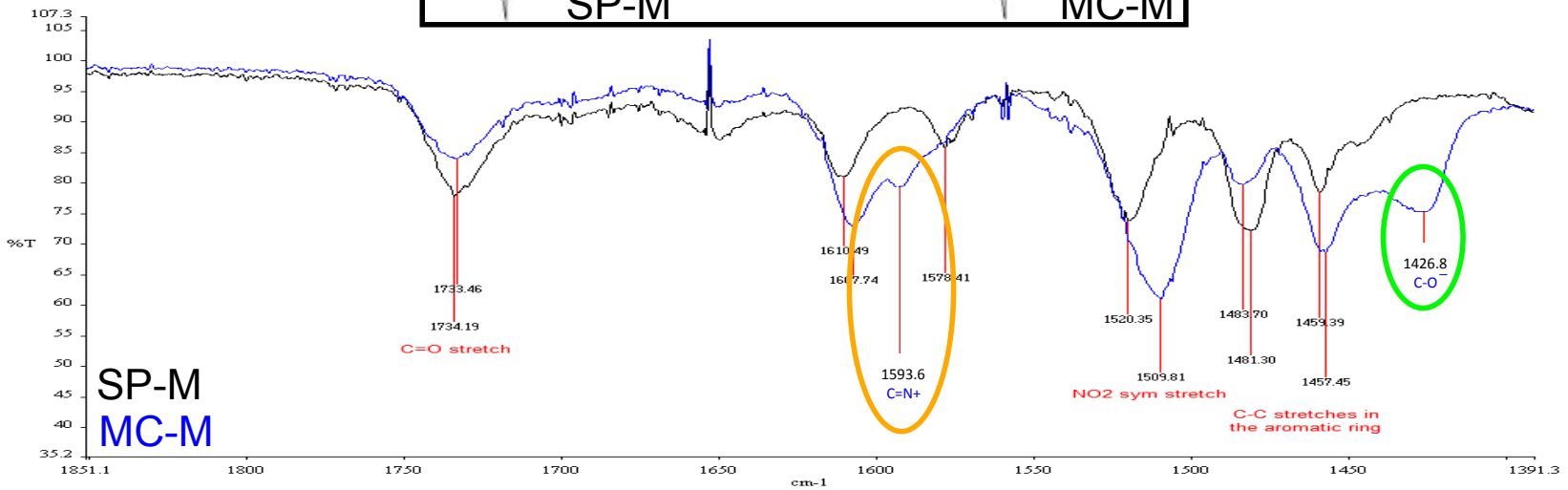
- polymer brushes
- high loading of spiropyran molecule
- 3D arrangement

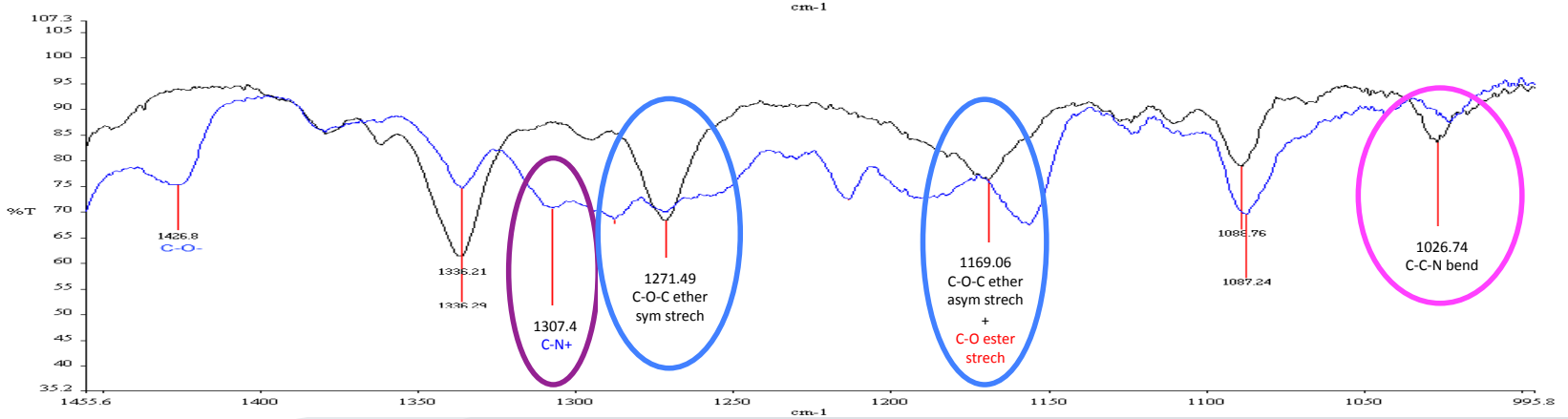
Synthesis of Spiropyran Monomer



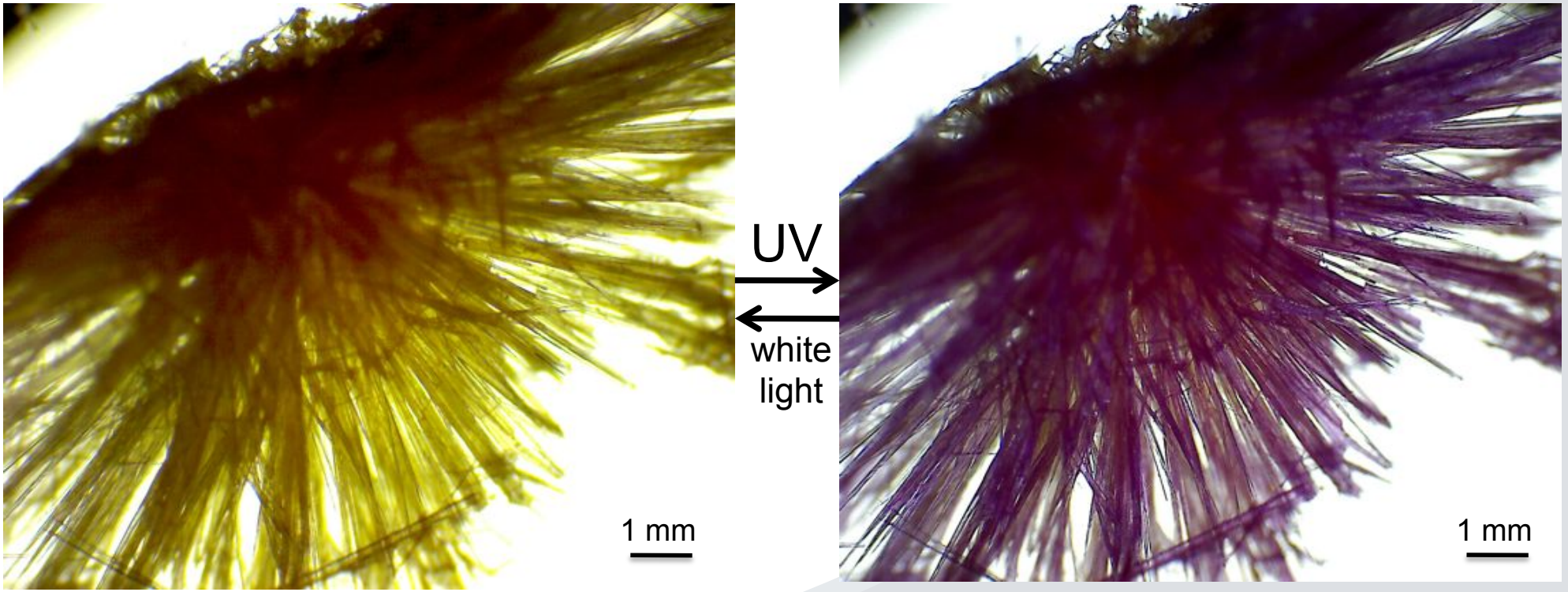
SP SP-M


UV
SP-M
MC-M


SP-M
MC-M
%T
cm-1
1733.46
1734.19
C=O stretch
1610.49
1593.6
C=N+
1520.35
1509.81
NO2 sym stretch
1483.70
1481.30
1459.39
1457.45
C-C stretches in the aromatic ring
1426.8
C-O⁻

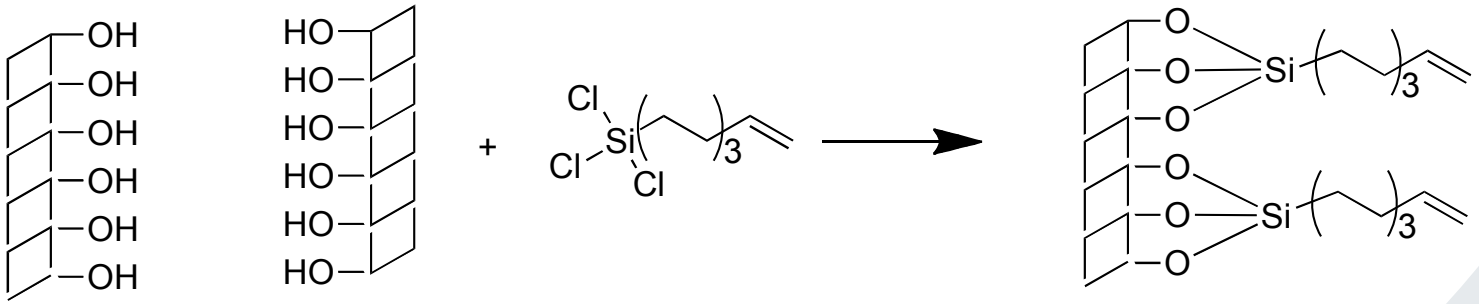

%T
cm-1
1426.8
C-O-
1336.21
1336.29
1307.4
C-N+
1271.49
C-O-C ether sym strech
1169.06
C-O-C ether asym strech
+
C-O ester strech
1088.76
1087.24
1026.74
C-C-N bend

Spiropyran-norbornene monomer

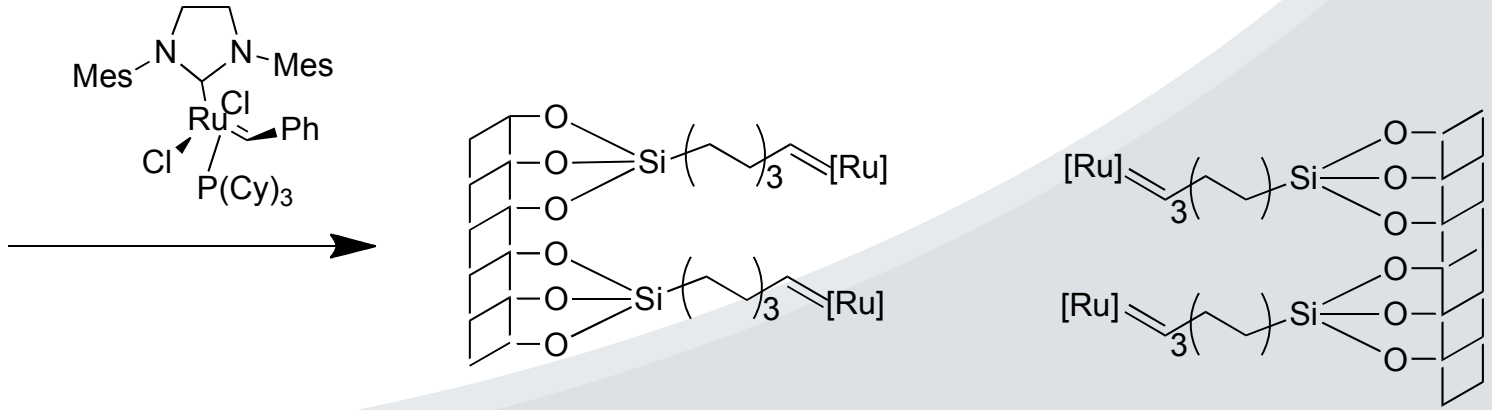


Spiropyran polymeric brushes in micro-capillaries

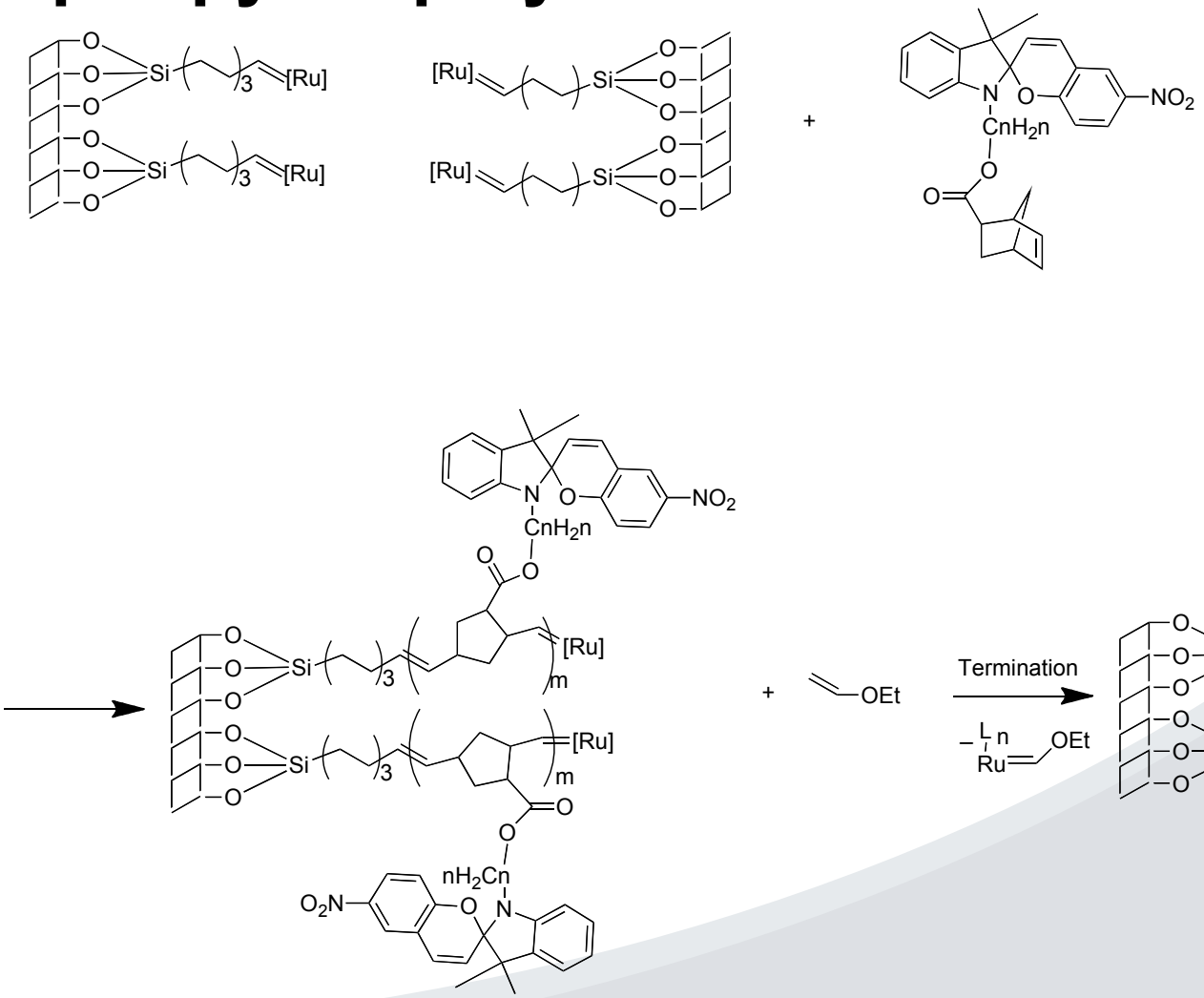
Silanisation



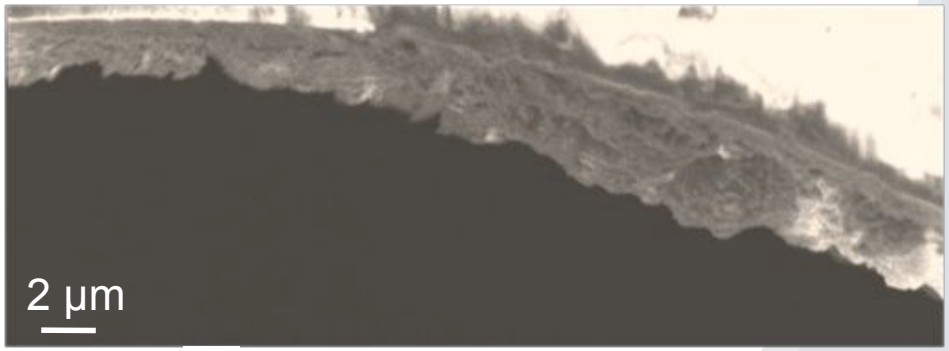
Attachment of the catalyst

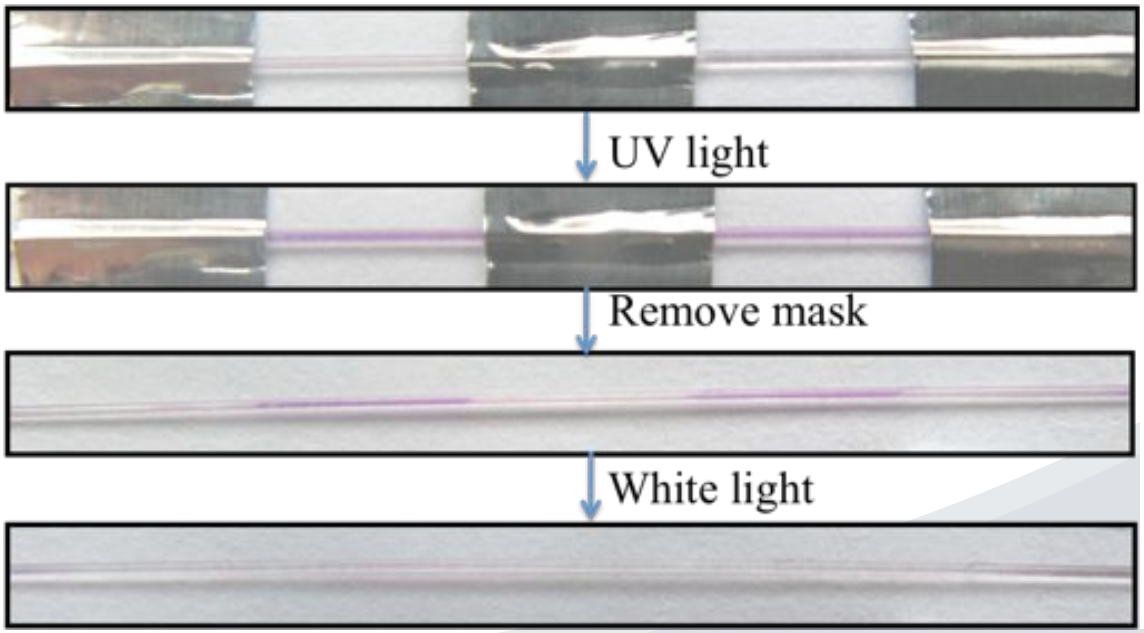


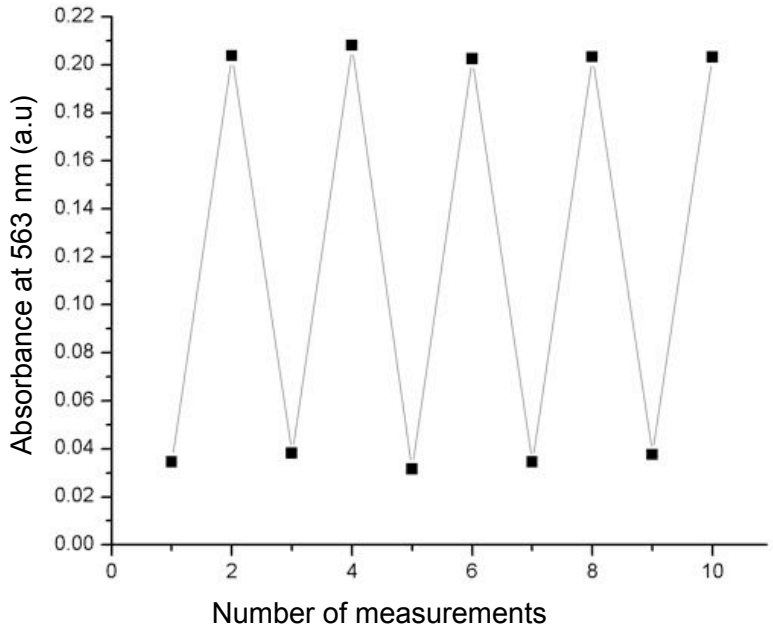
Spiropyran polymeric brushes in micro-capillaries



Characterisation







Metal ions sensing binding and releasing

I. Solution studies

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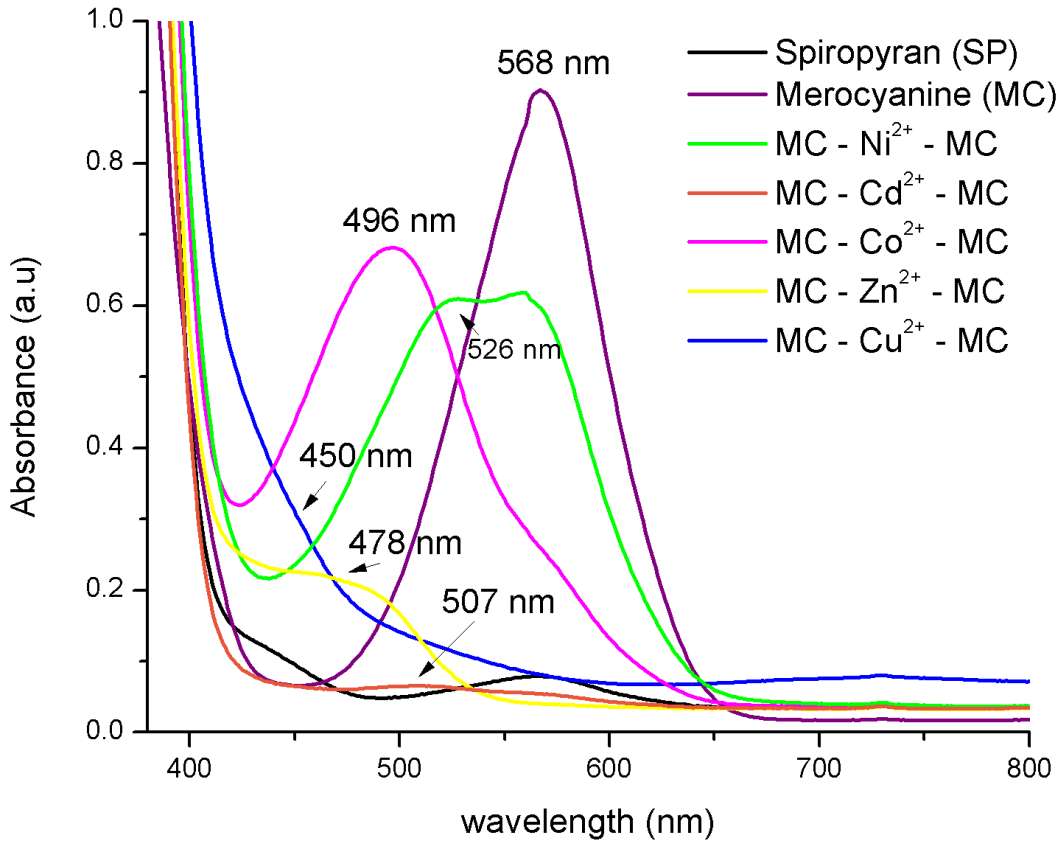
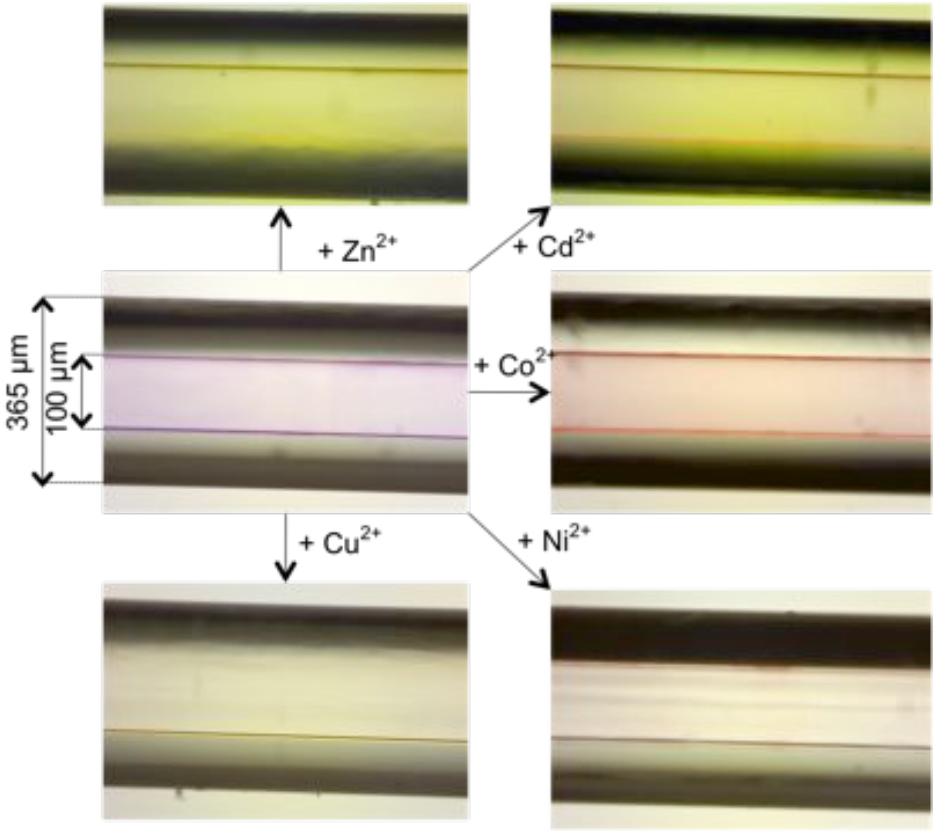
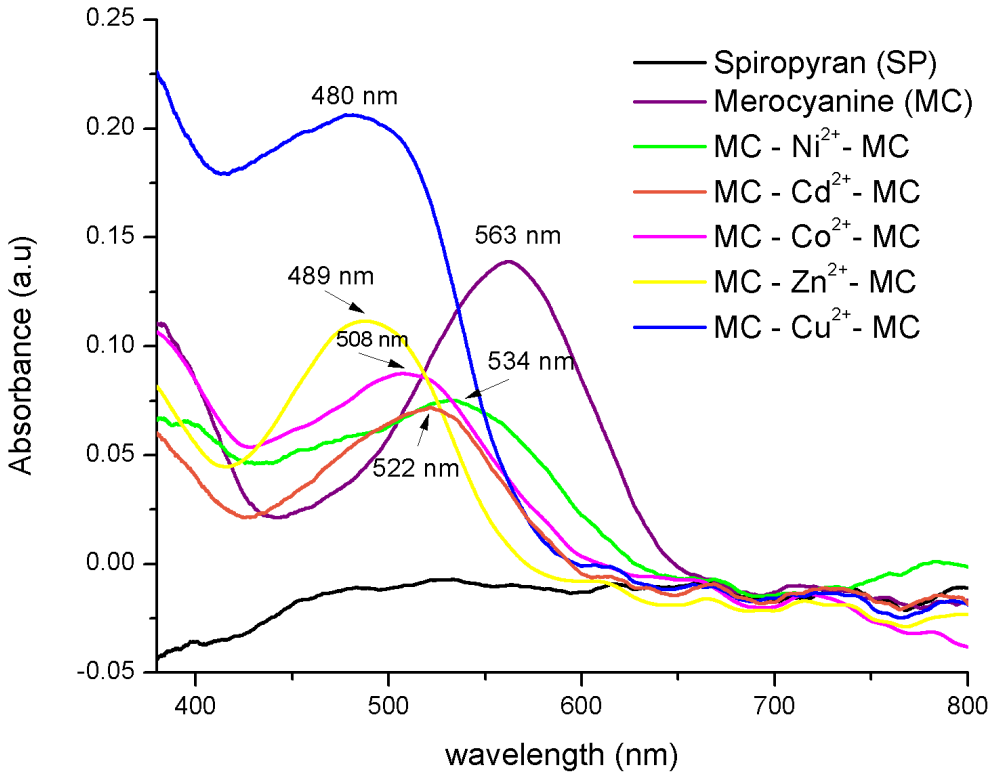


Cu^{2+} Zn^{2+} Co^{2+} Cd^{2+} Ni^{2+} MC

Metal ions sensing binding and releasing

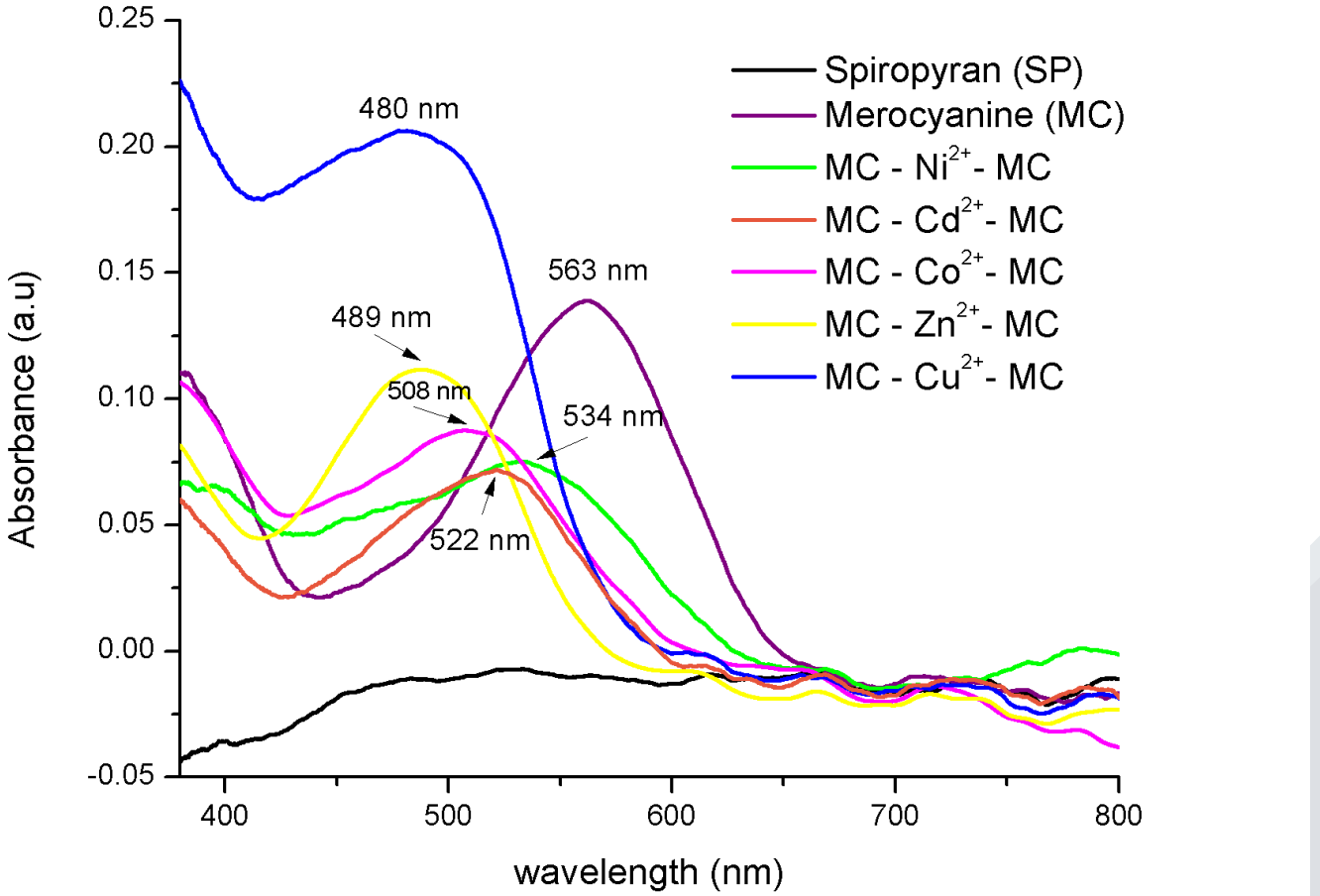
II. Capillary coatings





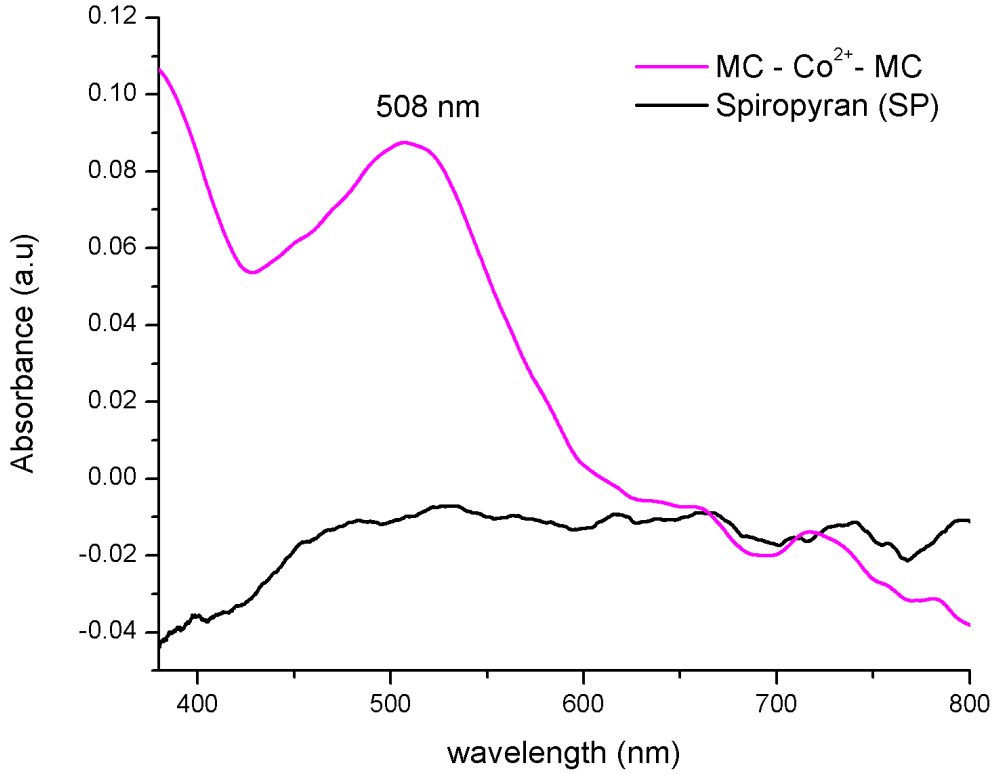
Metal ions sensing binding and releasing

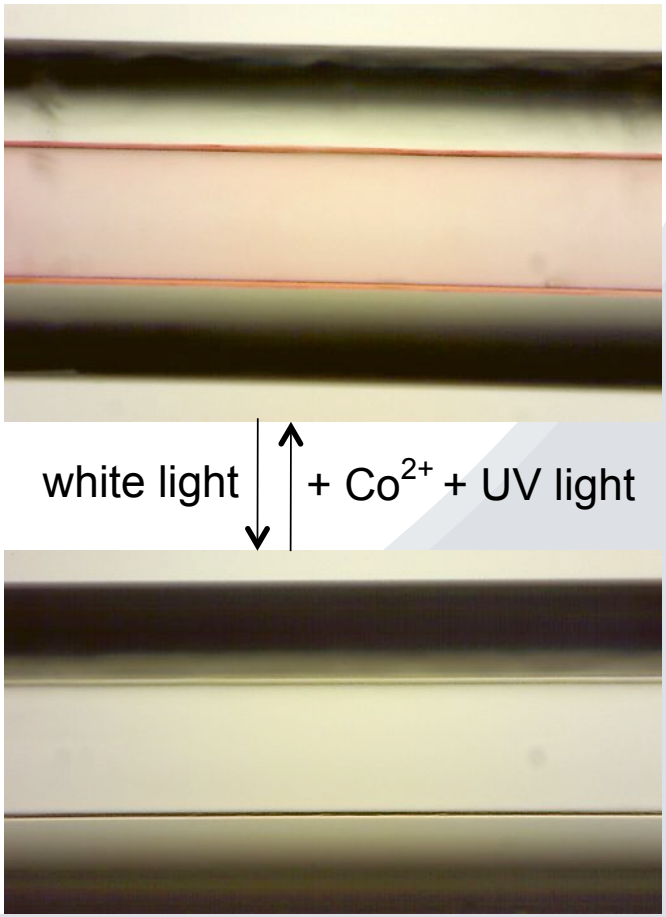
II. Capillary coatings



Cu^{2+} Zn^{2+} Co^{2+} Cd^{2+} Ni^{2+} MC

Metal ions binding and releasing





Conclusions

- First example of spiropyran polymer brushes in micro-capillaries
- Self-diagnostic for continuous flow device
- Metal ion detection in micro-capillaries
- Sensing behaviour can be switched on/off remotely using light

Acknowledgments

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Questions ?

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