Quantitative Photo-binding and Sensing of Divalent Metal Ions Using Photo-responsive Polymeric Brushes in Micro-capillaries

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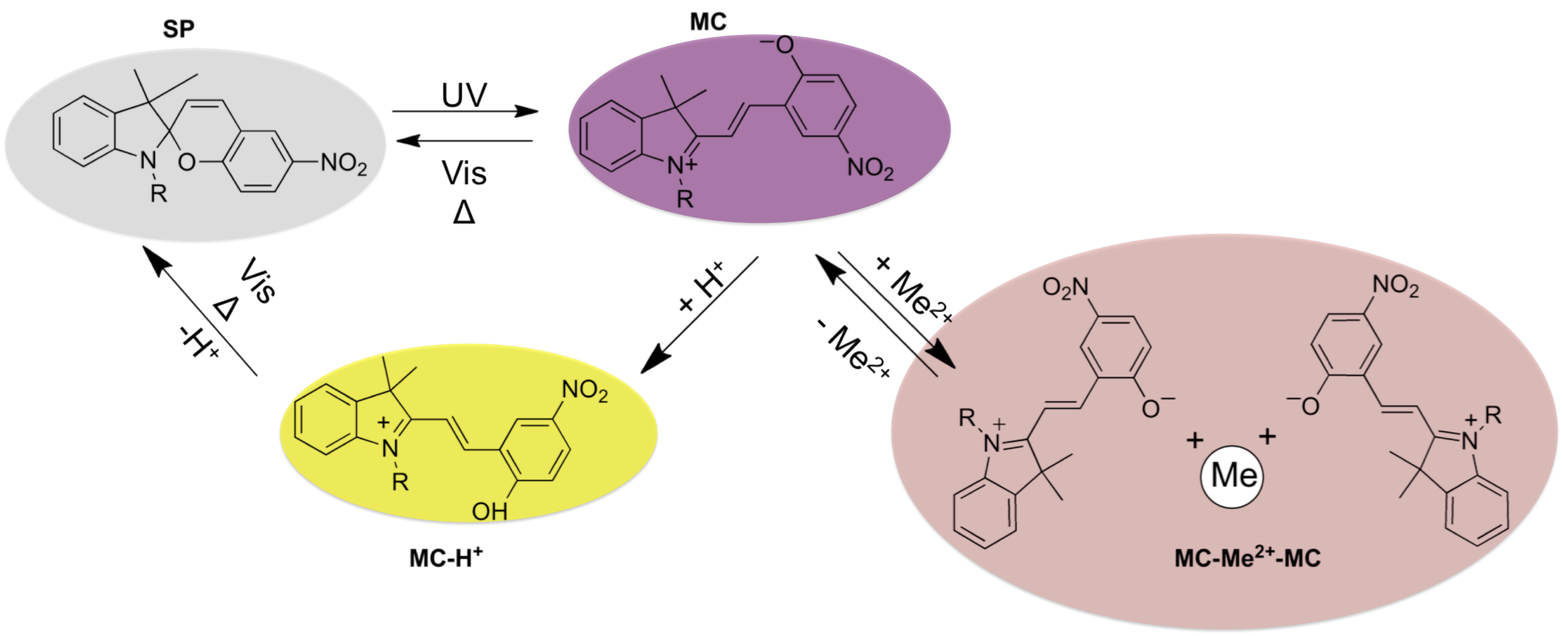
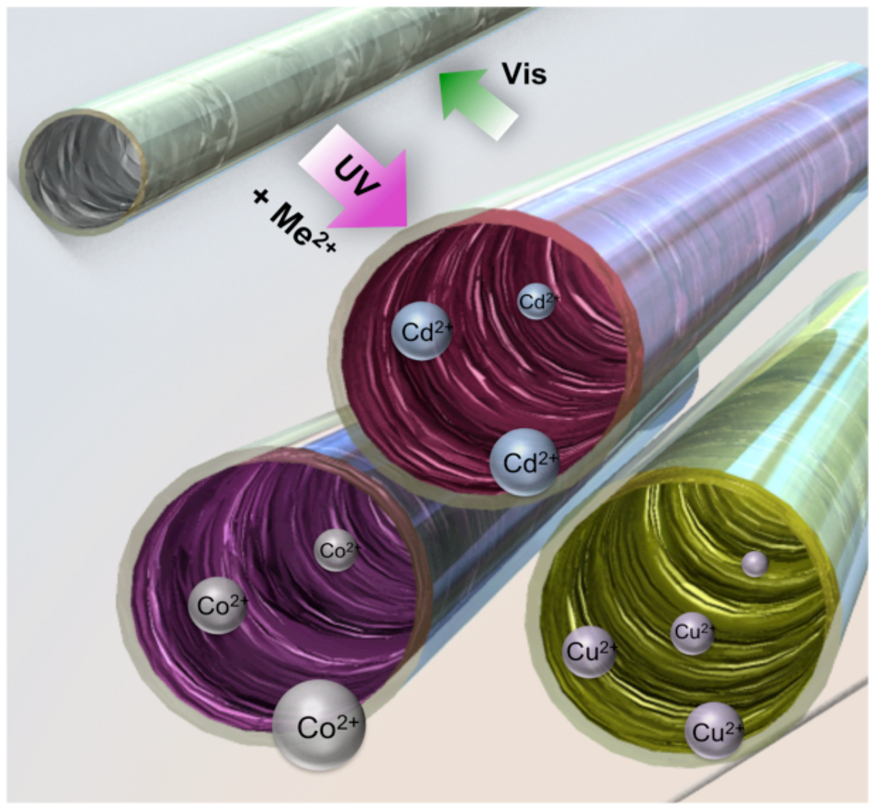
➢ Introduction

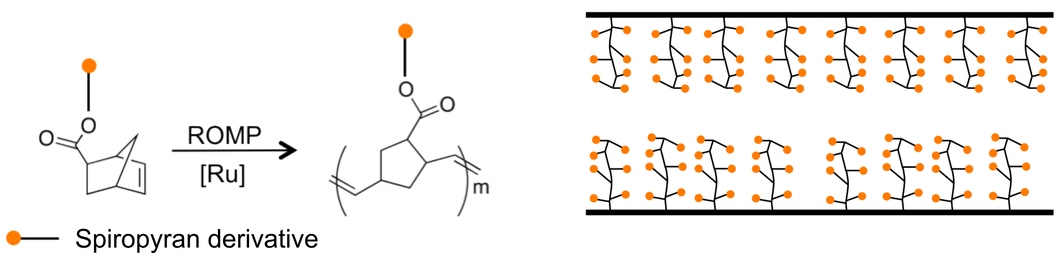
Here, we report for the first time quantitative photo-induced binding and sensing of a wide range of divalent metal ions in continuous flow regime using spiropyran photochromic brushes coated micro-capillaries. The polymeric brushes approach offers a nanostructured to microstructured responsive coating ensuring small diffusion paths and fast response times.

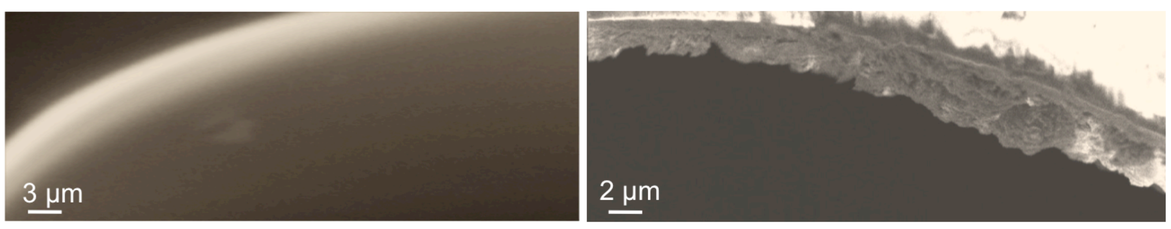




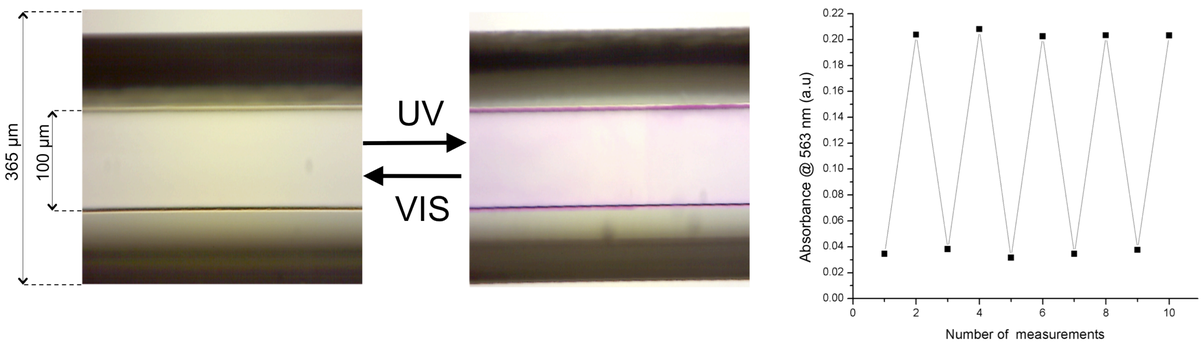
➢ Micro-capillary Functionalisation Process

The inner walls of fused silica micro-capillaries were successfully coated with spiropyran polymeric brushes using surface-initiated ring-opening metathesis polymerisation. Scanning Electron Microscopy imaging of the SP brushes inside the micro-capillary showed that coatings having lengths of about 2-3 μm were obtained.

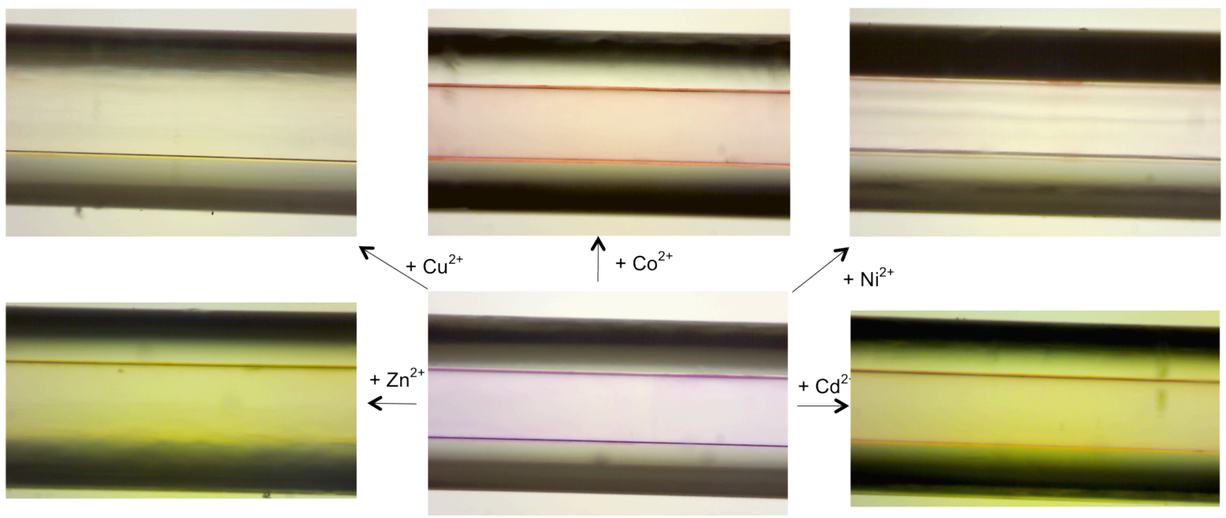




➢ Photochromic Performance

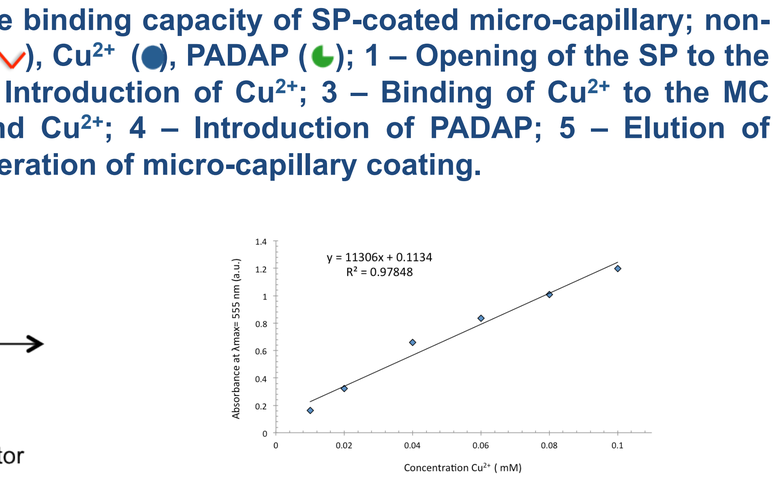


➢ Metal Ions Sensing

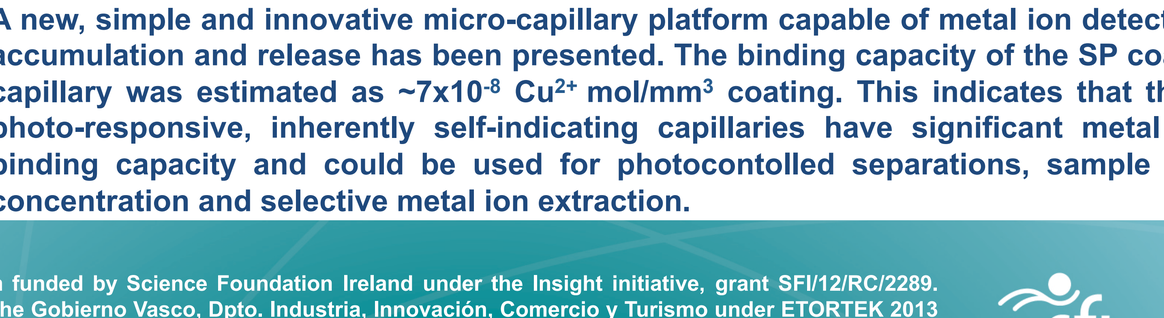


➢ Qualitative Binding

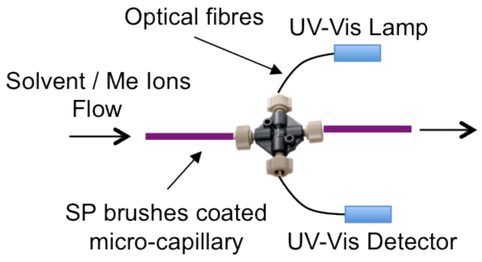
SP-polymer brushes modified micro-capillaries are capable of detecting different metal solutions that are passing through the modified micro-capillary in continuous flow, based on changes in colour (absorbance spectra) of the coating after irradiation with UV light. Five different metal ions solutions of Co^{2+}, Ni^{2+}, Cu^{2+}, Cd^{2+} and Zn^{2+} were detected.



➢ Quantitative Binding



Quantitative determination of the binding capacity of SP-coated micro-capillary; non-binding form (◇), binding form (✓), Cu^{2+} (●), PADAP (◔); 1 – Opening of the SP to the MC by UV light irradiation; 2 – Introduction of Cu^{2+}; 3 – Binding of Cu^{2+} to the MC form and washing of non-bound Cu^{2+}; 4 – Introduction of PADAP; 5 – Elution of PADAP-Cu^{2+} complex and regeneration of micro-capillary coating.



➢Conclusions

A new, simple and innovative micro-capillary platform capable of metal ion detection, accumulation and release has been presented. The binding capacity of the SP coated capillary was estimated as ~7x10^{-8} Cu^{2+} mol/mm^3 coating. This indicates that these photo-responsive, inherently self-indicating capillaries have significant metal ion binding capacity and could be used for photocontolled separations, sample pre-concentration and selective metal ion extraction.

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