Photo-responsive polymers based on spiropyran as sensors and actuators

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Insight

Introduction

Spiropyrans offer new routes for the fabrication of multifunctional materials since it is possible to take advantage of their photo-reversible interconversion between the two thermodynamically stable states of the molecule: a spiropyran (SP) form, and a merocyanine (MC) form. By adding acid, the opened MC is protonated to the hydrophilic protonated merocyanine (MCH^+) form, which can be reverted back to the closed hydrophobic SP by irradiation with white light. A metal ion-binding center can also be formed by a spatial rearrangement of opened MC forms, thus spiropyrans present a high interest for photo-reversible metal ion-complexation.

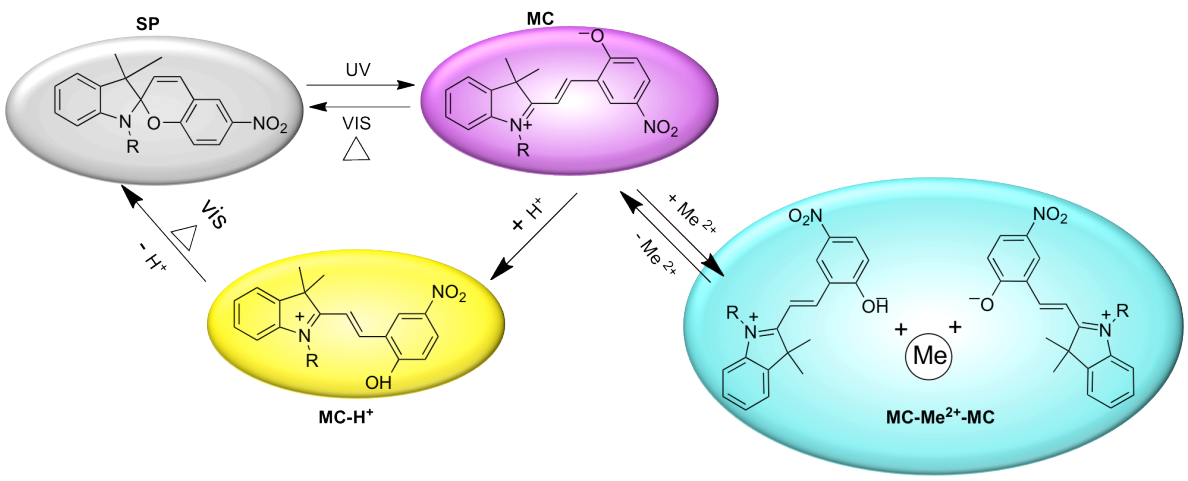
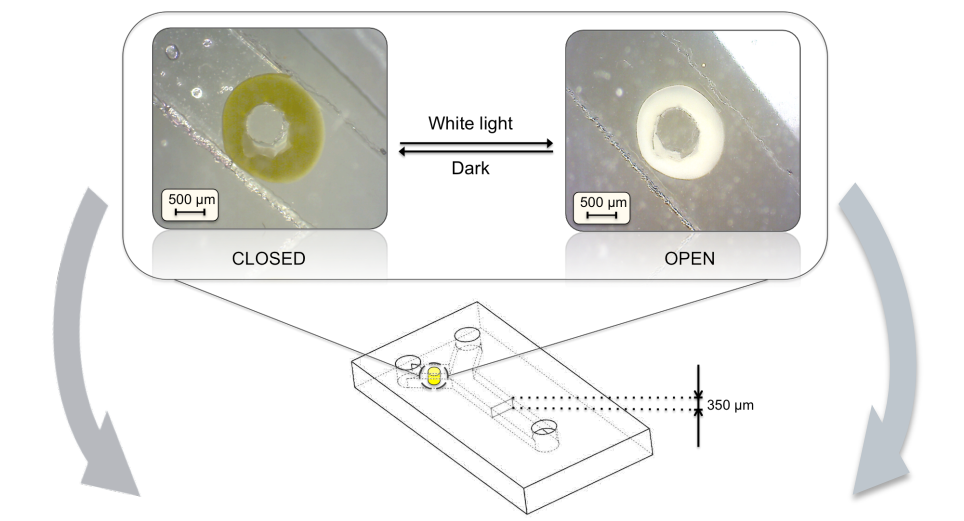
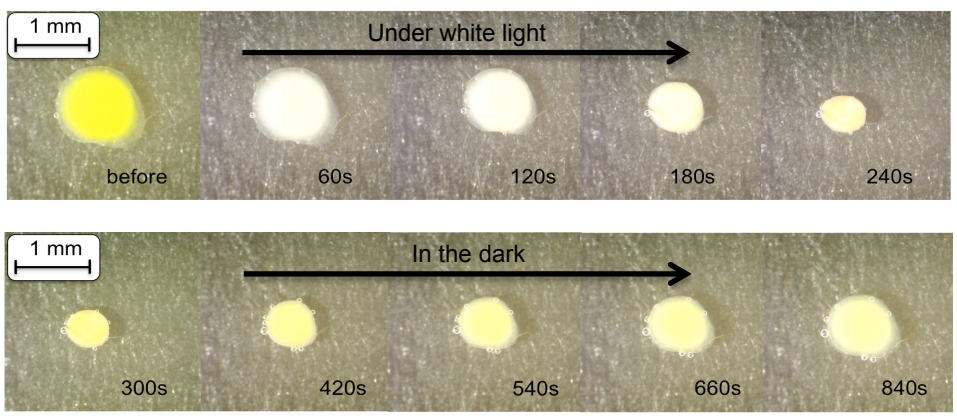
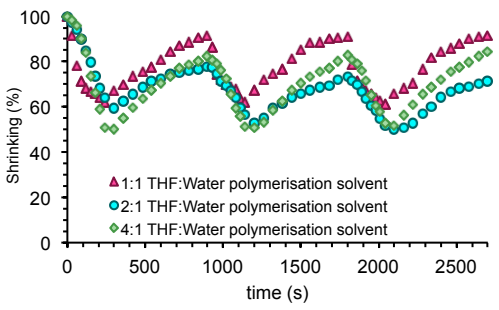


Photo-responsive Soft Actuators





Actuator p(NIPAAm-*co*-SP-*co*-AA) micro-structured hydrogels were photo-polymerised through micro-patterned masks. Their photo-induced shrinking and reswelling mechanism was studied under white light irradiation and in the dark. This shrinking and re-swelling cycle can be repeated with great reproducibility.



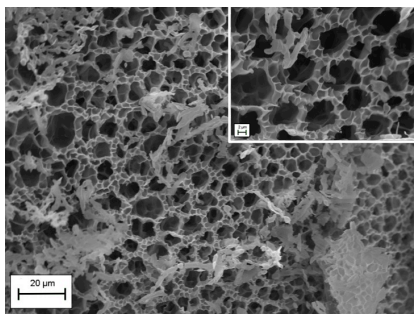
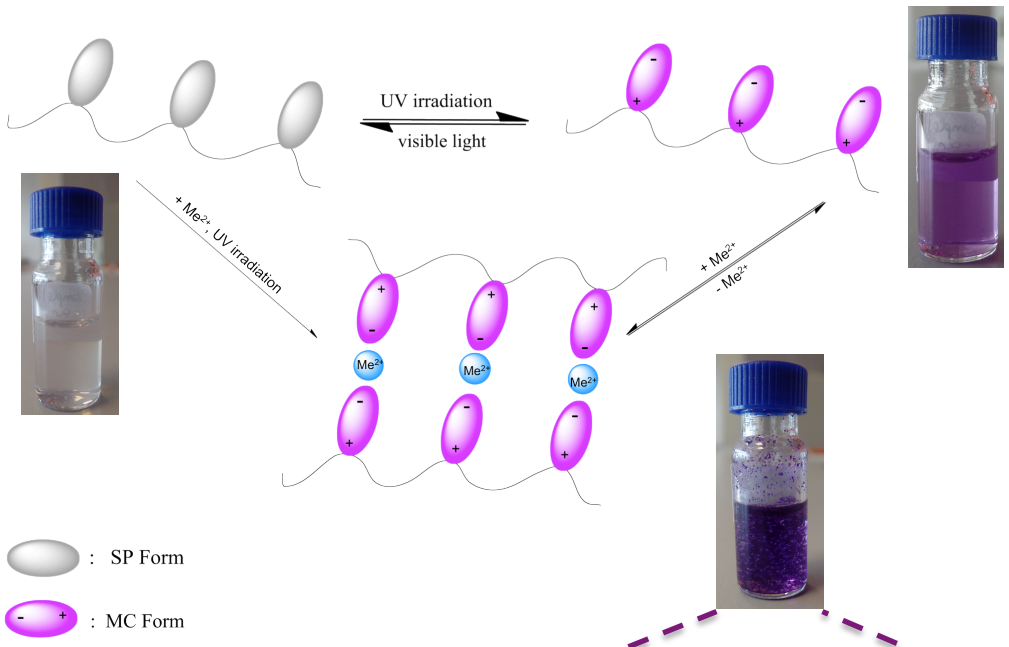
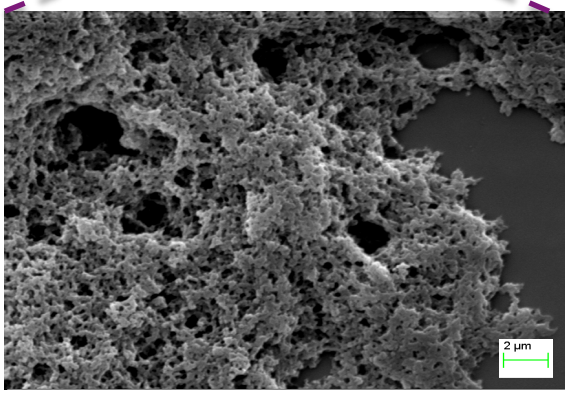


Photo-induced Assembly

Photo-induced aggregation of polynorbornenes was demonstrated in the presence of different metal ions upon irradiation with UV light. Throughout this study, it has been shown that the aggregation of the samples was facilitated by an increasing polymer chain length, and metal ions with higher binding affinities. Copper ion showed the highest binding affinity of the 5 metal ions tested (Cu^{2+}, Co^{2+}, Ni^{2+}, Zn^{2+}, Ca^{2+}).



SEM imaging confirmed the aggregation of polynorbornene polymers in the presence of different metal ions upon UV light irradiation. Although none of the samples showed de-aggregation under white light irradiation, on demand photo-induced aggregation was demonstrated and characterized.



Conclusion

Here we presented several means of integrating spiropyran photochromic molecules in different polymeric materials and their successful use as photo-actuators and photo-controlled optical sensors for a variety of target analytical species (divalent metal ions, H^+). By combining the key advantages of the spiropyran moiety with the smart engineering of spiropyran-based polymers, new materials with designed macroscopic properties can be obtained.

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