Patterned Photo-crosslinking of Switchable Hydrogel Coatings

Sander Kommeren, C.W.M. Bastiaansen

Functional Organic Materials & Devices, Dept. of Chemical Engineering and Chemistry, TU/e
5600 MB Eindhoven, The Netherlands

Switchable hydrogel systems

Switchable hydrogel systems with surface structures are being investigated as potential anti-fouling coatings. For instance, it is possible that switching the surface structure with external triggers, such as temperature, prohibits the adhesion of marine organisms and/or induces the detachment of the marine organisms.

Polymer design

To make a switchable hydrogel system that is compatible with industrial coating techniques, it is preferred to use a polymer based paint instead of a monomer based paint. Therefore a terpolymer that has several functionalities already built in is used. The terpolymer is made switchable by using N-(isopropyl acrylamide) (NIPAm), which is thermo-responsive when polymerized. To create a polymer network the terpolymer has to be crosslinked after polymerization, this is achieved by adding a photo-crosslinking monomer, Benzophenone acryl amide (BPAm) with acrylic acid (AaC) to increase the hydrophilicity. The structure of the resulting terpolymer is shown in Figure 1.

Methods

A typical terpolymer was synthesized from 92.3 mol% NIPAm, 1.9 mol% and 5.8 mol% (AaC). The resulting poly(NIPAm-co-BPAm-co-AAC) (PNBA) terpolymer was doctor bladed to produce 25 µm thick coatings on a glass surface treated with 3-(Trimethoxysilyl)propyl methacrylate. The PNBA coating was patterned using two subsequent UV exposure steps. A schematic representation of this process is shown in Figure 3.

Results

PNBA coatings are patterned by photo-crosslinking with a mask (lines with a 20µm pitch). Due to the different swelling ratios of the different crosslink densities, the PNBA coatings obtained surface structures upon immersion in water. Measurements of the surface structures gave an average height of 1.6 ± 0.8µm. Upon an increase in temperature above the lower critical solution temperature (LCST), the PNBA collapses, returning to its flat state, see Figure 4. This process is reversible and so it is possible to repeatedly switch the PNBA coating between a structured and a flat state.

Conclusion

We have described a novel method for preparation of switchable surface structures in surface attached hydrogels. The system is based on selective photo-crosslinking within the polymer which makes in suitable of industrial coating techniques. The surface structures were, on average, 1.6 µm high and could be switched to only 0.2 µm by increasing the temperature above the LCST and back by decreasing the temperature.

Acknowledgements

This project is supported by EU-FP7-SEAFRONT project

References