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Enhancement of photoswitchable wetting properties of SP-containing porous surfaces by roughness adjustment

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The fabrication of smart surfaces with photoswitchable wetting properties is of great interest for applications such as coatings with various wetting patterns[1], photo-controlled liquid imbibition[2] or condensation[3]. Spiropyran (SP) stands out among the photoswitches due to the significant dipole moment change from SP to merocyanine (MC), featuring a remarkable color change upon UV exposure. Roughness, as a key parameter for the wetting behavior of a surface, needs to be adjusted to enhance the static contact angle (SCA) switch as well. However, common fabrication methods to fabricate SP functionalized surfaces with a suitable roughness have some drawbacks such as complicacy and surface sensitivity.
In this work, synthesized SP monomer was incorporated into the bulk material, ensuring that the fabricated photoswitchable substrates remained functional after abrasion. A micro-/nanoscale roughness was introduced to the material via the polymerization-induced phase separation (PIPS) method [4] to amplify the SCA switch. Polymers with different roughness were achieved by varying the crosslinker content, as it influences the PIPS and shrinkage. SCA was measured on all the samples before and after UV exposure. According to our results, not only the SP but also the pore size (i.e. roughness) is a crucial parameter for tuning the photoswitchable wetting properties. For samples with larger pores, low roll-off (RA) angles and high SCA, indicate the dominance of the Cassie-Baxter state. This results in less SP/MC contact and hence, insignificant SCA change. While samples with smaller pores could provide SCA changes up to 16l° as the Wenzel State would be dominant, allowing for a higher interface of SP/MC and the droplet. Samples with the highest SCA change also exhibited greater coalescence of condensed water droplets at the micro- and macroscale after UV exposure with lower hydrophobicity.

References

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