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Underwater superoleophobicity cellulose nanofibril aerogel through regioselective sulfonation for oil/water separation

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Abstract

Cellulose nanofiber (CNF) aerogel regioselectively modified by sodium periodate oxidation and consecutive sodium sulfite sulfonation has been fabricated. The aerogel exhibits underwater superoleophobicity (θ_{oil} >150°) characteristic for various oils, which could be used as a filter for oil/water separation. Compared with originals, the charge density of sulfonated CNF increased from -39.8 mmol/kg to -325 mmol/kg, which prevented the aggregation in water suspension and resulted in better dispersion morphology of nanofibers in the final aerogel after freezing-drying. Therefore, modified aerogel with a good hierarchical structure and high charge density was able to trap more water molecules onto its voids once pre-wetted, which is energetically unfavorable for the oil to replace the water molecules. As a result, the sulfonated aerogel displayed superoleophobicity characteristic underwater thus nonpolar oil phase was completely repelled while the water easily penetrated the as-prepared aerogel. The sulfonated CNF aerogel maintained high oil-water separation efficiency by simply filtration. The oil content in filtrated water was always less than 300 ppm (0.03%), and kept a stable recyclability even after 20 cycles, which could be practically used as a filter for oil/water.

1. INTRODUCTION

Expanding industrial oily wastewater and frequent oil spill accidents have caused increasing