Zwitterionic microgel based anti(-bio)fouling smart membranes for tunable water filtration and molecular separation

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Abstract

Antifouling Membranes with tunable properties which can separate and regulate flow based molecular properties of solutes as well as avoid the loss of performance owing to adsorption of different foulants and biofilm formation by bacterial growth, have the potential to revolutionize the separation industry. Recent research in this area is focussed on the various types of surface modification techniques, inclusion of antifouling and antimicrobial material, and use of nanomaterials. However, most of the alternatives have several drawbacks or not meeting the basic criteria. Microgels (three-dimensional cross-linked polymeric particle) can serve as a suitable template for such modifications, which possess stimuli-responsive size tunability, high water holding properties, and possibility of further functionalization. Herein, we are reporting the fabrication of smart thin nanostructured membranes using zwitterionic microgels on support membrane by suction filtration. The microgels were synthesized using grafting from copolymerization of N-isopropylacrylamide and polyethyleneimine (PEI), later free amine groups of PEI chains of microgel were modified with 1,3-propane sultone for zwitterionization. Thermo-responsive Size tunability from 716 to 405 nm under the application of temperature from 24°C to 40°C and the uniform core-shell morphology of microgel was confirmed by DLS, SEM and TEM data, respectively. Prepared membranes were also thoroughly characterized to analyze the surface properties, protein adsorption, water permeation, MWCO, and solute rejection properties. Results showed that zwitterionic membrane provides better hydrophilicity, lower BSA adsorption, and desirable antimicrobial activity. Increase in thickness of microgel layer leads to a prominent thermo-responsive water permeance with high gating ratio, narrowed pore size distribution with mean pore size from 1.33 nm to 0.74 nm, almost complete dye rejection and flux recovery, and better anti-fouling properties. Easy preparation technique, long-term stability, and diverse applicability of zwitterionic microgel membranes turn it to a unique and interactive membrane for various pressure-driven separation and purification applications.

Keywords:

Zwitterionic microgels; Thermo-responsive membrane; Anti(-bio)fouling; Antibacterial; Water purification.