Fabrication of antifouling membrane surface by poly(sulfobetaine methacrylate)/polydopamine co-deposition

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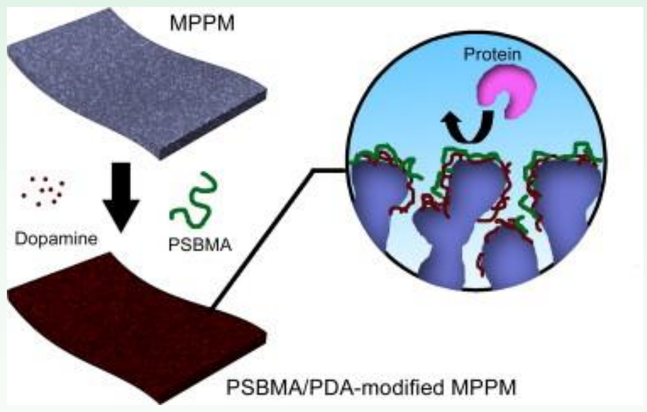
Introduction

Poly(sulfobetaine methacrylate) (PSBMA) has been widely employed for the surface modification of membranes due to its excellent antifouling property. [1-5] However, challenges still remain to simplify the modification processes and to increase the utilization efficiency of PSBMA (or sulfobetaine methacrylate, SBMA). Since 2007, it has been found that dopamine (DPA) can be oxidized under alkaline conditions and spontaneously polymerizes to form a thin, surface-adhering polydopamine (PDA) film on a wide spectrum of materials with various morphologies. [6,7] In this paper, a simple one-step co-deposition process is introduced to fabricate antifouling surfaces for microporous polypropylene membranes (MPPMs) based on the self-polymerization and high adhesion properties of dopamine with the hydrophilicity of PSBMA.

Experimental and results



Scheme 1. Schematic illustration of the one-step co-deposition of PSBMA/PDA for antifouling membrane surfaces.

Characterization

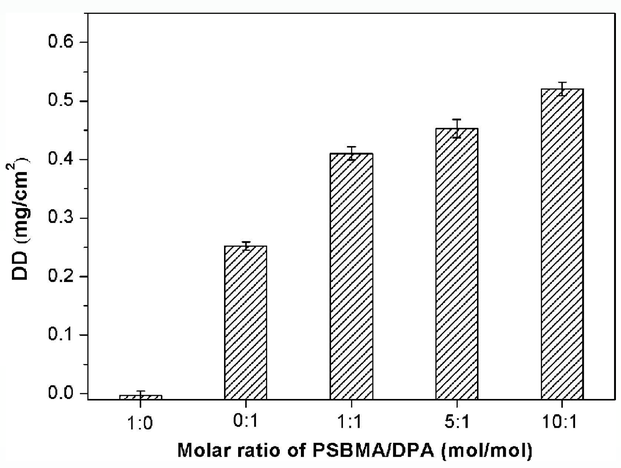


Figure 1. Effect of PSBMA/DPA molar ratios on the deposited density for the modified membranes.

PSBMA was synthesized by free radical polymerization. It was mixed with DPA in Tris buffer solution under alkaline condition and then deposited onto the surfaces of MPPM. Herein, we studied the influence of PSBMA concentration on membrane modification by varying the molar ratio of PSBMA/DPA .

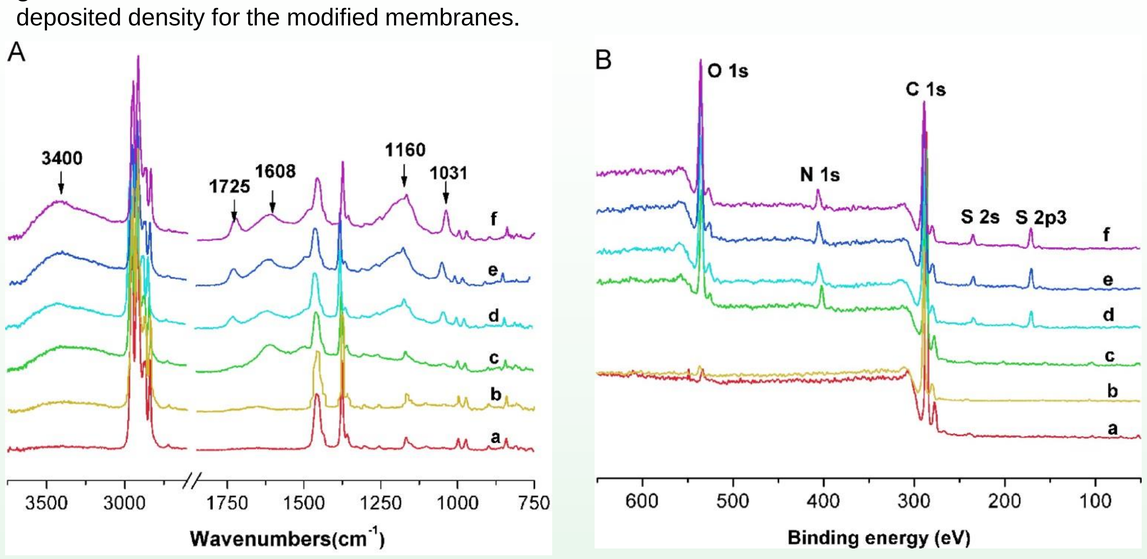
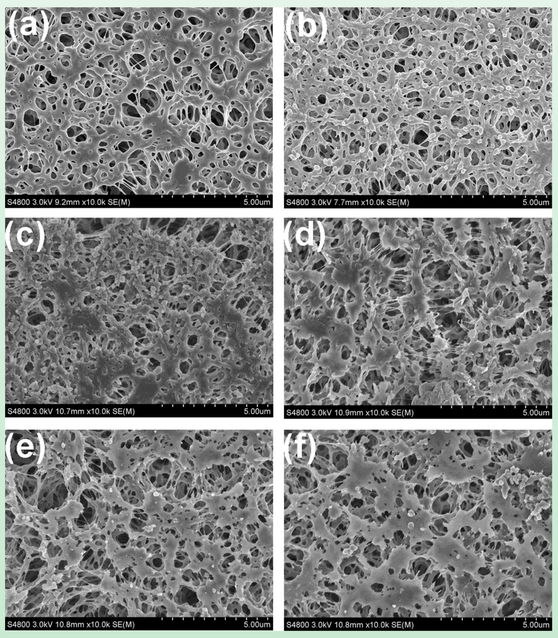


Figure 2. ATR/FT-IR (A) and XPS (B) spectra of the nascent MPPM (a), PSBMA-modified MPPM (b), PDA-modified MPPM (c) and PSBMA/PDA-modified MPPMs (d, e, and f) with PSBMA/DPA molar ratios of 1:1, 5:1 and 10:1, respectively.



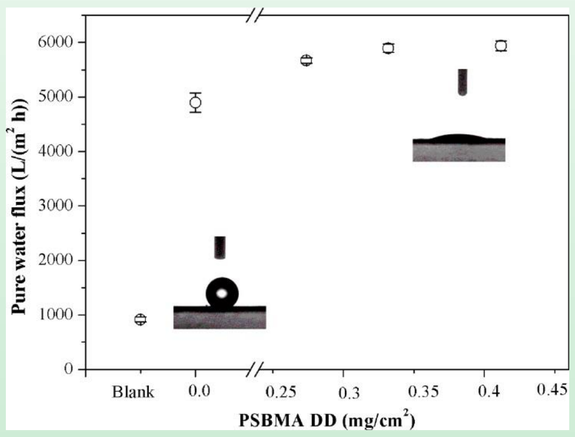
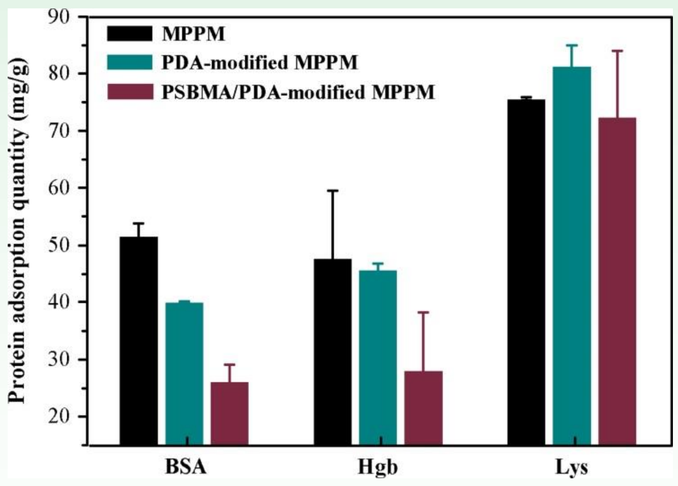


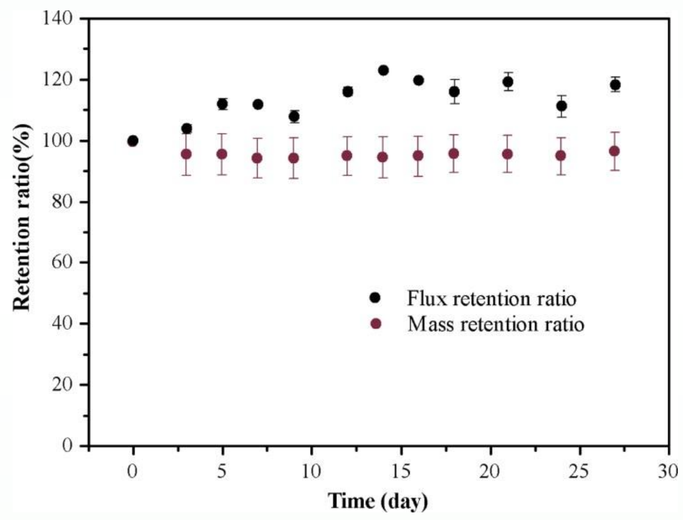
Figure 4. Pure water flux (0.1 MPa) and water contact images of the nascent and modified MPPMs with different deposited densities of PSBMA.

Figure 3. FESEM images of the surface morphologies for the nascent MPPM (a), PSBMA-modified MPPM (b), PDA-modified MPPM (c) and PSBMA/PDA-modified MPPMs (d, e, and f) with different PSBMA/PDA molar ratios (1.1, 1.5, and 2.1)..



It can be seen that the PSBMA/PDA-modified MPPMs present admirable resistance to the adsorption of BSA and Hgb. However, all membranes, especially the PDA-modified MPPM, show more quantity of adsorbed Lys than those of BSA and Hgb.

Figure 5. Protein (BSA, Hgb and Lys) adsorption quantity on the nascent MPPM, PDA-modified MPPM and PSBMA/PDA-modified MPPM (PSBMA/PDA=1.1/1.0).



It is important to sustain the antifouling properties during practical application for membranes. Therefore, the stability of PSBMA/PDA co-deposited coating was examined by washing the modified membranes in a shaken water bath at 60 ° C for different periods.

Figure 6. Flux and mass retention ratio of PSBMA/PDA-modified MPPM (PSBMA/PDA=1.5/1.0).).

Conclusions

Co-deposition of PSBMA in PDA-based coating is put forward as a facile and efficient one-step approach to fabricate antifouling surfaces for commercial hydrophobic membranes.

This endows the membranes with excellent hydrophilicity, low water flux reduction and high water flux recovery. And the modified membranes display distinct adsorption behaviors when faced with different charged proteins, which can be of great potential for application in protein separation.

Additionally, the PSBMA/PDA co-deposited coatings also show good stability in a long-term washing.

In conclusion, this one-step modification method acquires significant advantages over the existing ones for constructing antifouling membrane surfaces.

References

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