Antifouling and antimicrobial polyethersulfone membranes via surface quaternization mediated by polyethersulfone based copolymer additives

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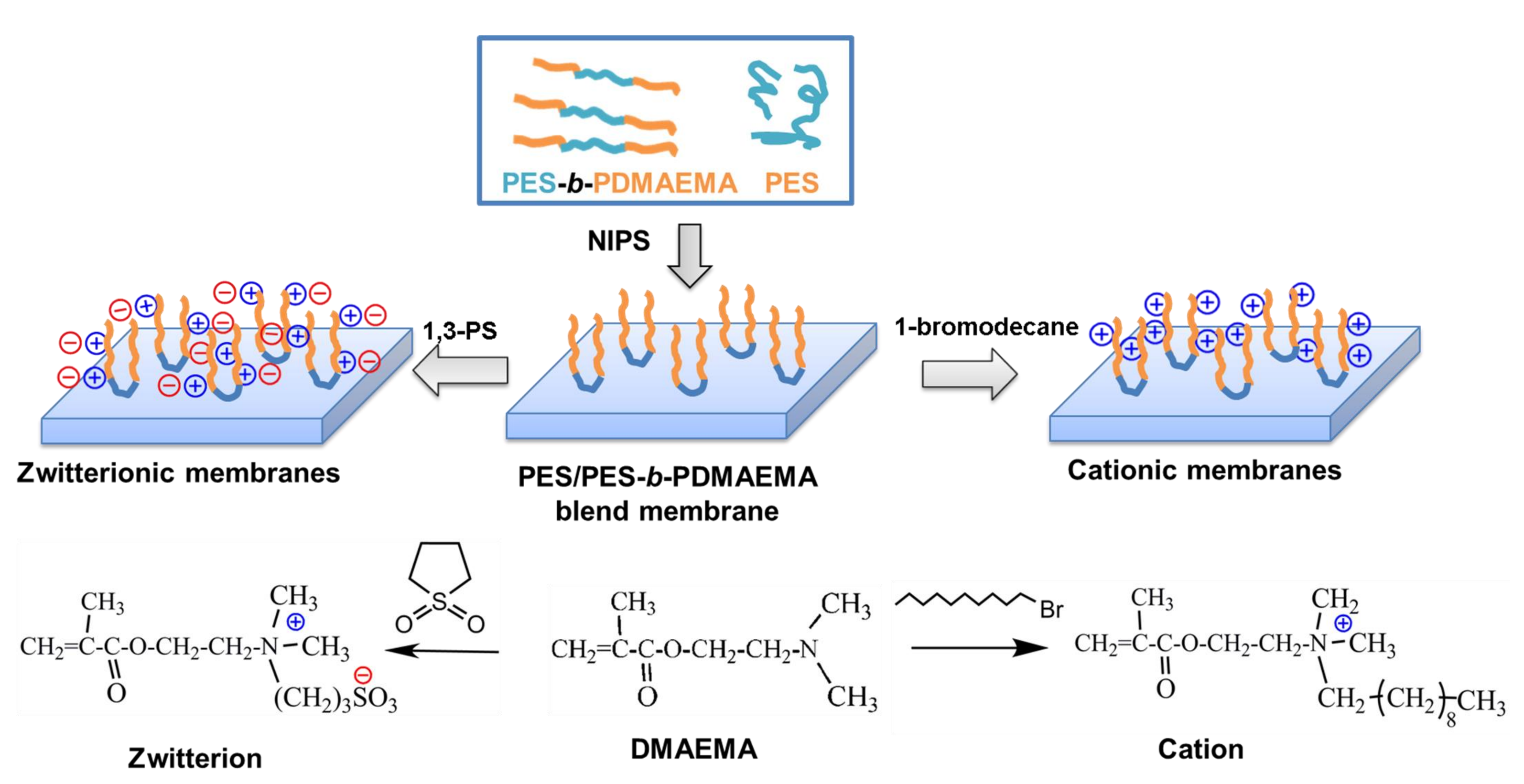
Introduction

Polyethersulfone (PES) is one of the most favorable polymers for preparing ultrafiltration (UF) membrane due to its good thermal stability, mechanical strength, and oxidation resistance. However, due to the low surface energy and inherent hydrophobic characteristics of PES，the contaminants were prone to adsorb onto membrane surface or into pore wall, leading to serious membrane fouling, platelet coagulation and significant operational cost. Therefore, PES membrane usually has to be modified to improve its antifouling, hemocompatibility and antimicrobial properties before its practical use. In the present work, amphiphilic precursor PES-*b*-PDMAEMA was firstly blended with PES to prepare PES/PES-*b*-PDMAEMA blend membranes via NIPS process. The surface-enriched PDMAEMA chains were then transformed into polyzwitterions or polycation via quaternization. with 1,3-propane sultone (*1,3-PS*) or 1-bromodecane.

Experimental



Results and Discussion

1.Fabrication and characterization of PES/PES-*b*-PDMAEMA blend membranes

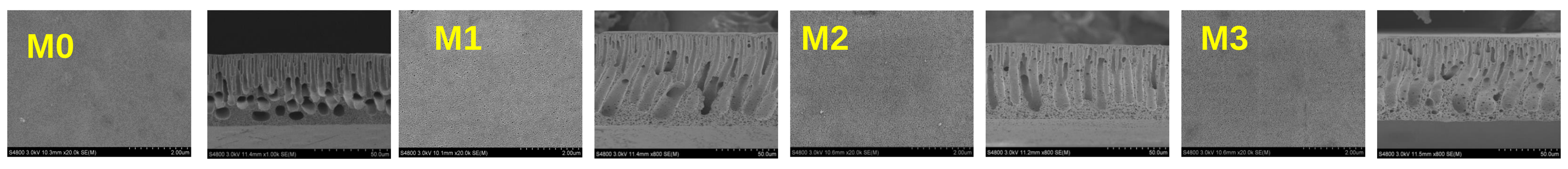
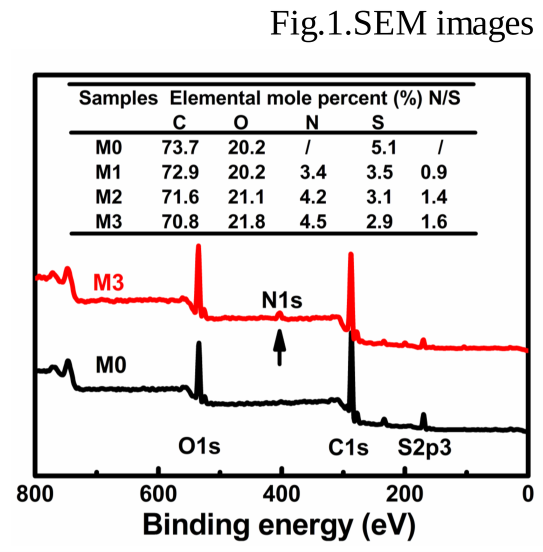
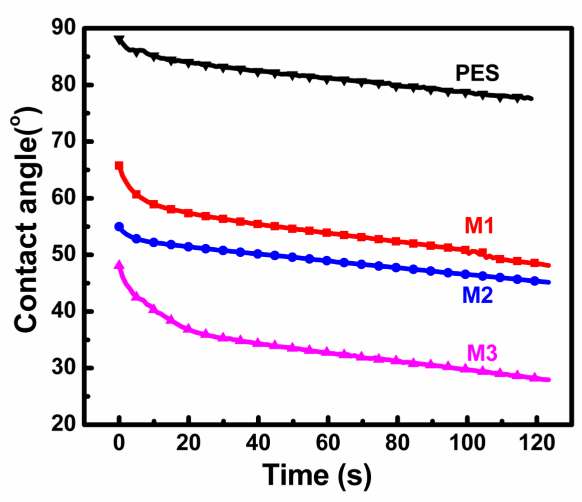


Fig.1.SEM images for membranes



(B)

Samples	Elemental mole percent (%)			
	C	O	N	S
M2-30º	71.2	21.4	4.5	2.9
M2-45º	71.7	21.1	4.1	3.1
M2-60º	72.4	20.2	3.9	3.5
M2-85º	73.1	19.9	3.7	3.3



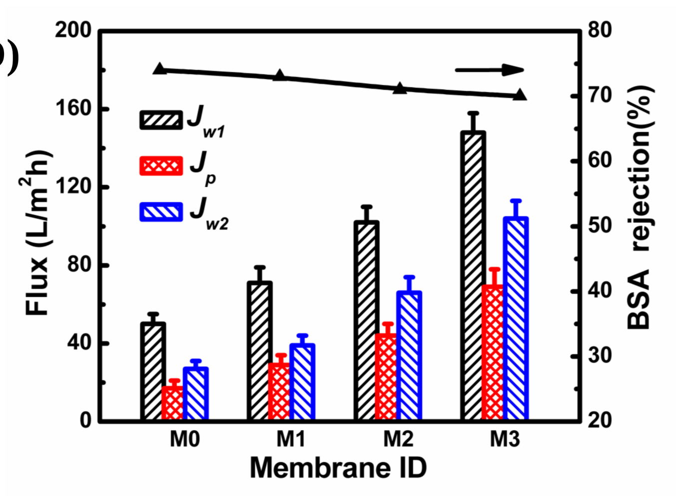


Fig. 2. (A) XPS wide scans and the elemental atomic percentages of membranes. (B) The surface elemental mole percentage of M2 detected by XPS with differet take-off angle. (C) The curves of water contact angle decaying with drop age for membranes. (D) The permeability and BSA rejection of membranes.

2. Polyzwitterions-modified PES membranes: improved antifouling property and blood compatibility polycation

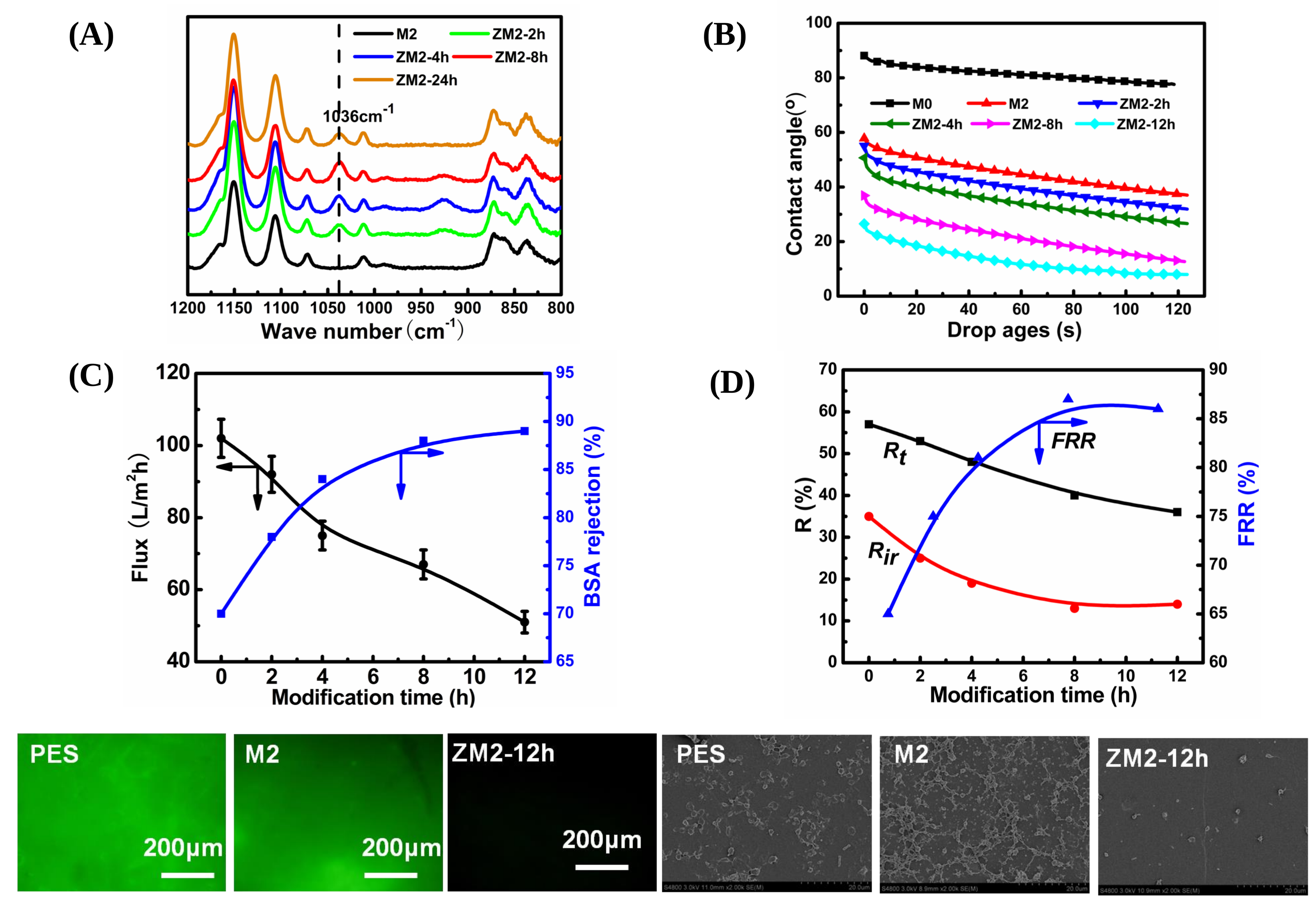


Fig.3. (A) FTIR/ATR spectra for the zwitterionic membranes. (B) The curves of water contact angle decaying with drop age. (C) The permeability and BSA rejection of zwitterionic membranes. (D) A summary of R_t, R_{ir} and *FRR* of zwitterionic membranes.

2.Polycation-modified PES blend membranes: improved antibacterial property

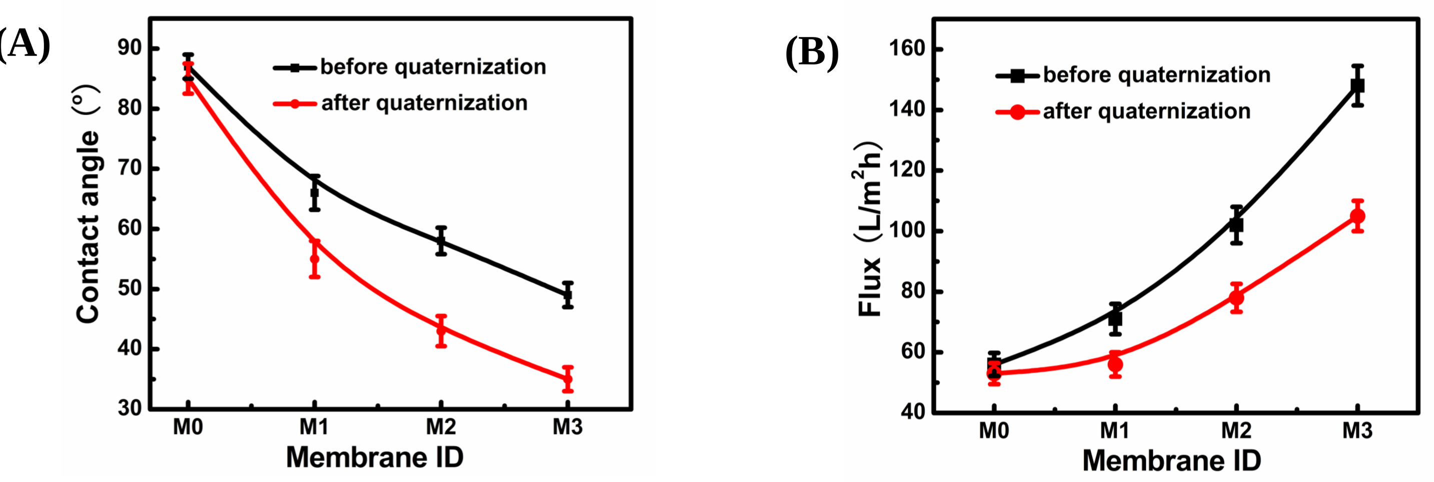


Fig.4. (A) The static contact angle of the blended membranes before and after quaternization. (B) The water flux of the blended membranes before and after quaternization..

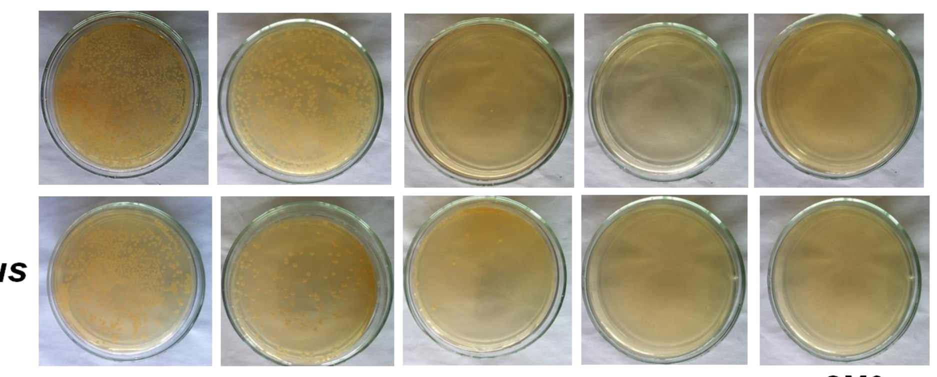


Fig.5. Antibacterial activities of the investigated membranes against (A) E. coli and (B) S. aureus.

Conclusion

After surface modification，the zwitterionic PES membranes showed significantly improved hydrophilicity, antifouling ability and hemocompatibility compared to the unmodified one. Moreover, the cationic PES membranes exhibited excellent antibacterial activities. This facile method provides a simple and practical method to fabricate antifouling and antimicrobial membranes on a large scale or in complex geometries.

Acknowledgements

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