A novel route to surface zwitterionization of polyamide nanofiltration membranes with improved performance

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Introduction

Zwitterionic polymers are attracting significant interest for nanofiltration membranes (NFMs) featuring exceptional permeability and antifouling performance, posing an urgent need for the effective integration of zwitterionic components into NF membranes.

Here we introduce a facile strategy incorporating a controlled amount of zwitterionic components (N-aminoethylpiperazine propane sulfonate, AEPPS) into polyamide thin film composite NF membranes prepared by the interfacial polymerization between trimesoylchlorid (TMC) and piperazine (PIP). By coating pristine polyamide NFMs with AEPPS solution, reactive AEPPS molecules were effectively anchored to the membrane surface via chemical reactions between primary amine groups on AEPPS and acyl chloride groups on the membrane surface. The incorporated AEPPS components are shown to enormously improve membrane permeability without compromising salt rejection and better antifouling property.

Experimental

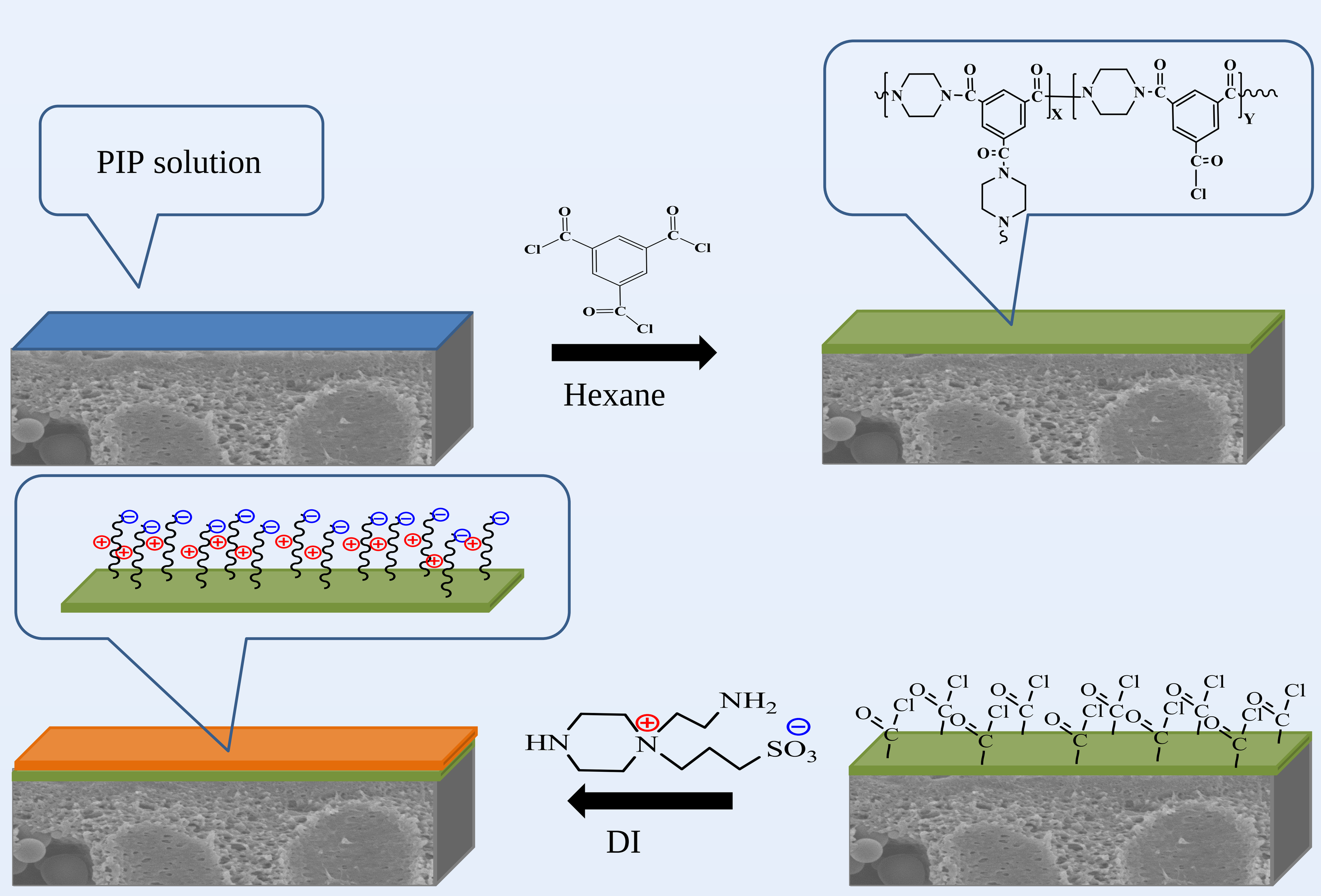


Fig.1. The preparation of ziwtterionic PIP-TMC-AEPPS NFMs.

Results and discussion

I. Chemical structures and compositions of NFMs

Membrane	Atomic Conc. (mol%)				$Ratio_{AEPPS}$ (mol%)
	C(1s)	N(1s)	O(1s)	S(2p)	
NFM-0	71.57	13.71	14.72	0	0
NFM-1	71.27	15.48	12.84	0.41	8.0
NFM-2	70.83	14.9	13.76	0.51	10.8
NFM-3	73.17	13.22	13.07	0.53	12.9

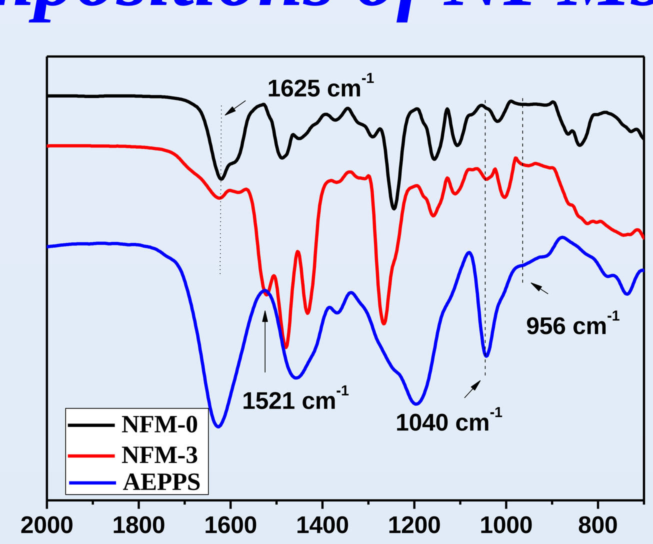


Fig.2. ATR-FTIR and XPS of zwitterionic NFMs

II. Surface characterizations of NFMs

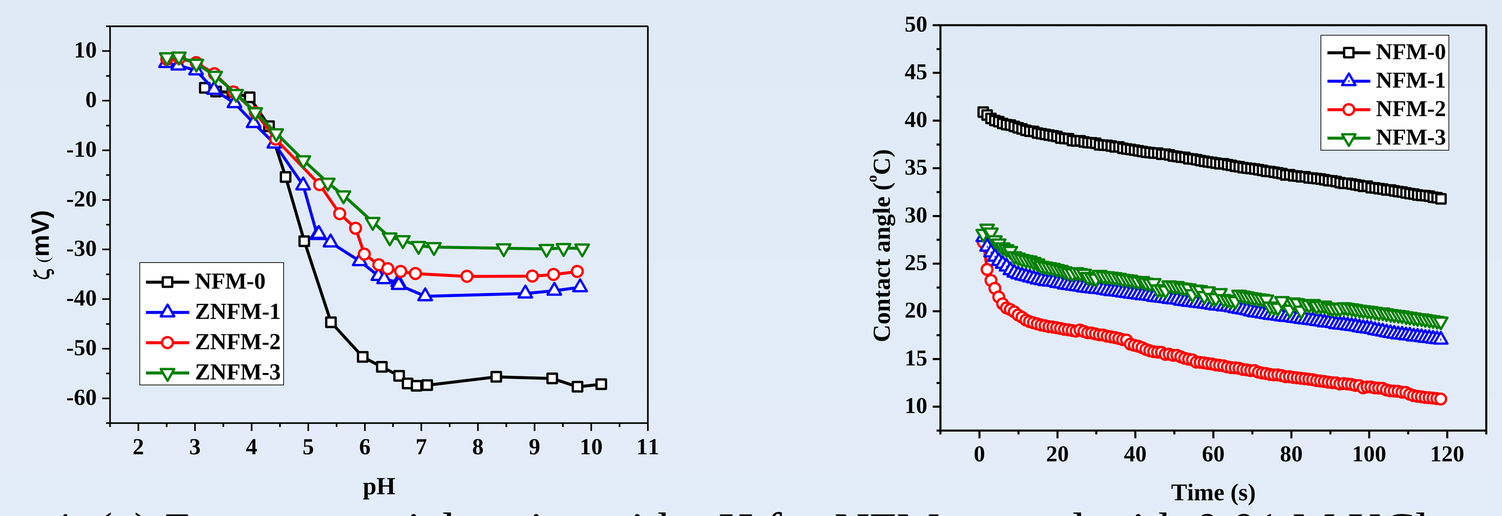


Fig. 4. (a) Zeta pontential varies with pH for NFMs tested with 0.01 M KCl aqueous, (b) Dynamic water contact angles of NFMs.

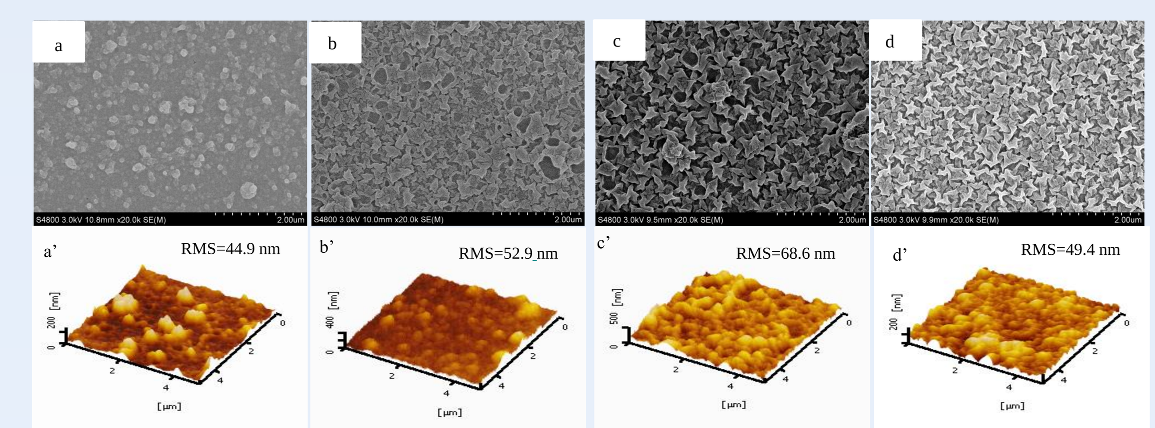


Fig. 6. FESEM and AFM surface morphologies of (a/a') NFM-0, (b/b') NFM-1, (c/c') NFM-2 and (d/d') NFM-3.

III. Nanofiltration performance of NFMs

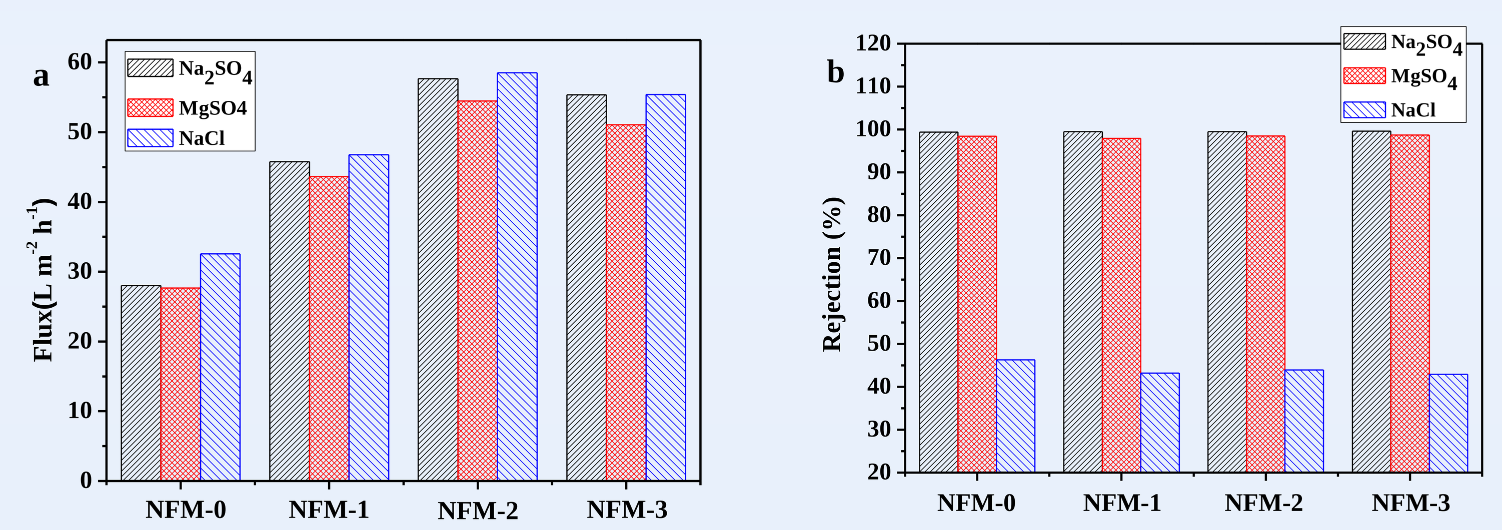
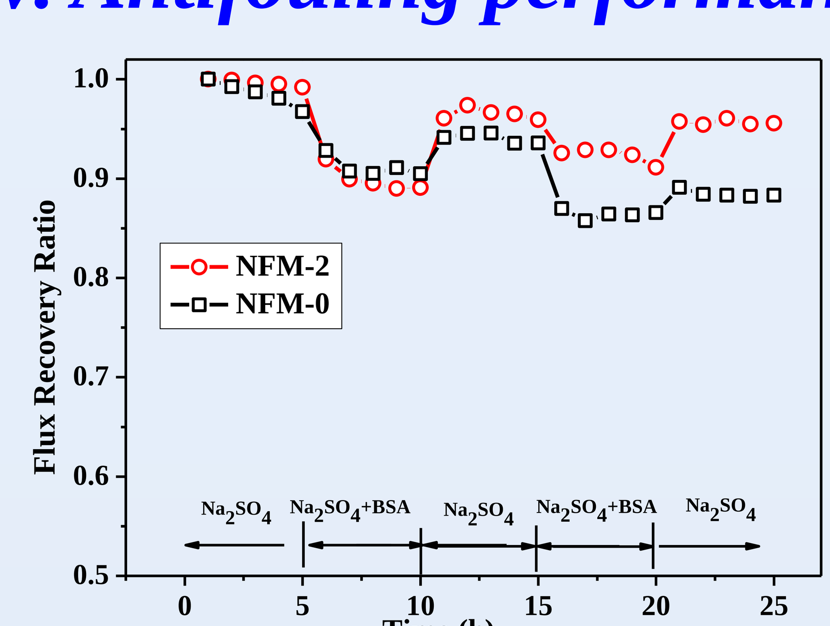


Fig. 7. Nanofiltration performance of NFMs tested with 1g L^{-1} different inorganic salt aqueous solutions at 25 ^{o}C and 0.6 MPa: (a) water flux and (b) salt rejection.

IV. Antifouling performance of NFMs



zwitterionic membrane has better antifouling performance

Fig. 8. Time dependent water flux recovery ratio of NFM-0 andNFM-2 tested with 1 g L^{-1} Na_2SO_4 and 1 g L^{-1} Na_2SO_4+0.1 g L^{-1} BSA aqueous solution (pH= 6.0±0.1) at 25 ^{o}C under the same initial water flux.

Conclusions

This work provides a facile method for incorporating zwitterionic monomer onto NF membrane surface. When tested with 1g L^{-1} Na_2SO_4 aqueous solution at 0.6 MPa, 25 ^{o}C, the large degree of flux improvement without compromising salt rejection. In addition, zwitterionic NF membranes exhibit better antifouling property.

Acknowledgements

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