

Introduction

- Polysaccharide nanofiltration (NF) membranes with traditional modification normally suffers from poor water permeability as a result of its tight packing of polymeric chains.
- A novel membrane building block, polyelectrolyte complex (PEC) nanoparticles (NPs) armed with adjustable content of sulfated groups is developed using chitosan (CS) and dextran sulfate sodium (DSS).
- Intrinsic aggregation structure combined with numerous sulfate groups attenuates packing density of polymeric chains and promotes hydrophilicity, endowing membranes (SPECMs) prepared by solution-casting method with high flux.
- The prominent perm-selectivity associated with antifouling property suitably position SPECMs for practical small organic molecule/inorganic salt mixture separation in a long-term process.

Experimental

Preparation of the SPECMs

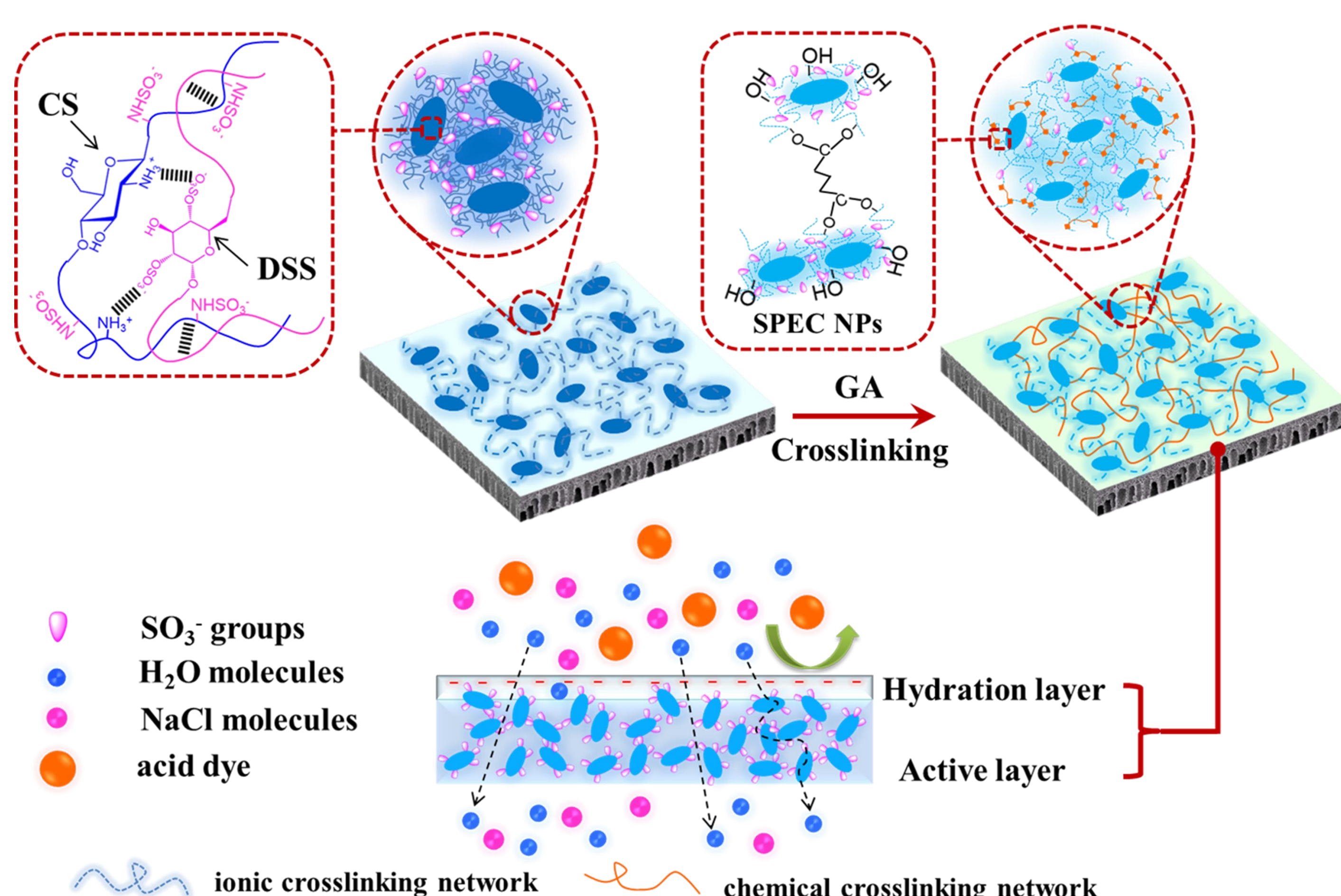


Fig. 1. Schematic diagram of chemical structure, membrane fabrication and dye/salt mixture separation process of SPECMs.

Results and discussion

Characterizations of SPEC NPs and SPECMs

Table 1 Compositions of PEC and their SPECs determined by XPS.

Sample	Feed ratio (mol%) (sulfate agent : CS)	S (At.%)	N (At.%)	S : N	DC ^a (mol%)	DS ^b (mol%)	Membrane
PEC	—	2.97	6.60	0.45	45	—	—
SPEC-1	1.0	3.95	6.27	0.63	45	18	M-1
SPEC-2	2.0	4.46	5.95	0.75	45	30	M-2
SPEC-3	3.0	5.02	5.84	0.86	45	41	M-3
SPEC-4	3.5	5.26	5.72	0.92	45	47	M-4
SPEC-5	4.0	5.27	5.67	0.93	45	48	M-5

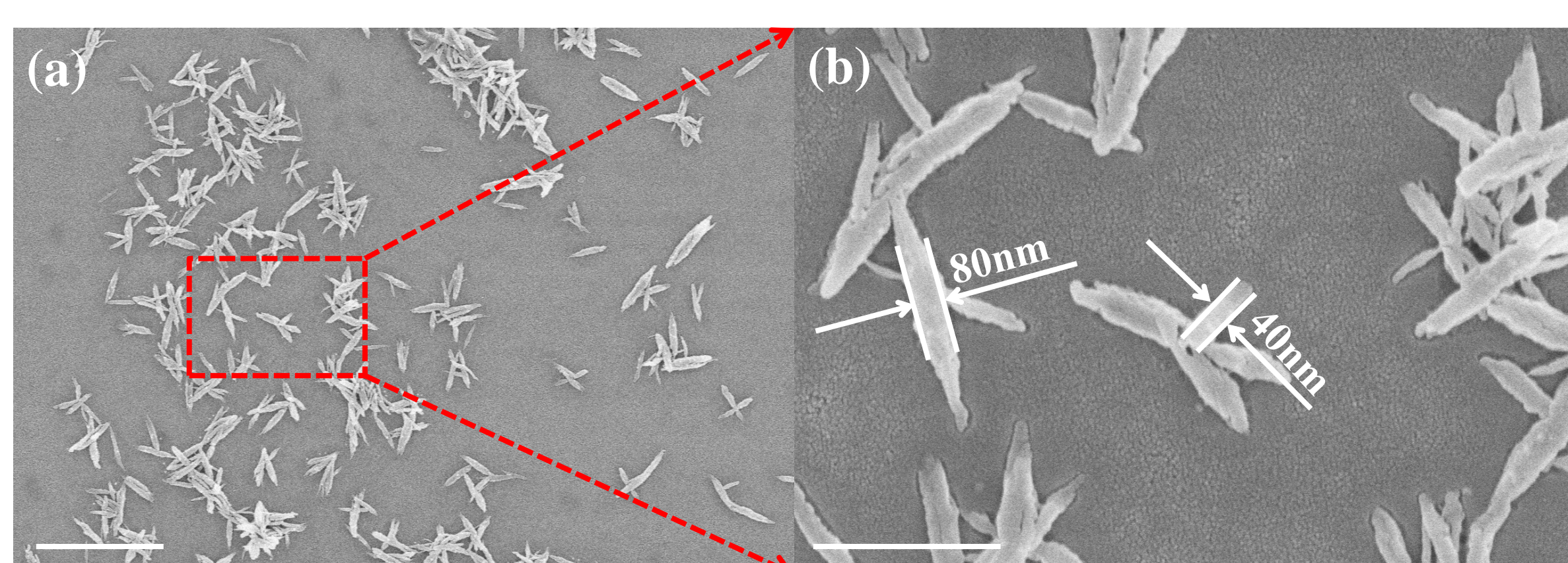


Fig. 2. (a) SEM micrographs of SPEC-4 (scale bar: 2 μm) and (b) magnified image in (a) (scale bar: 500 nm).

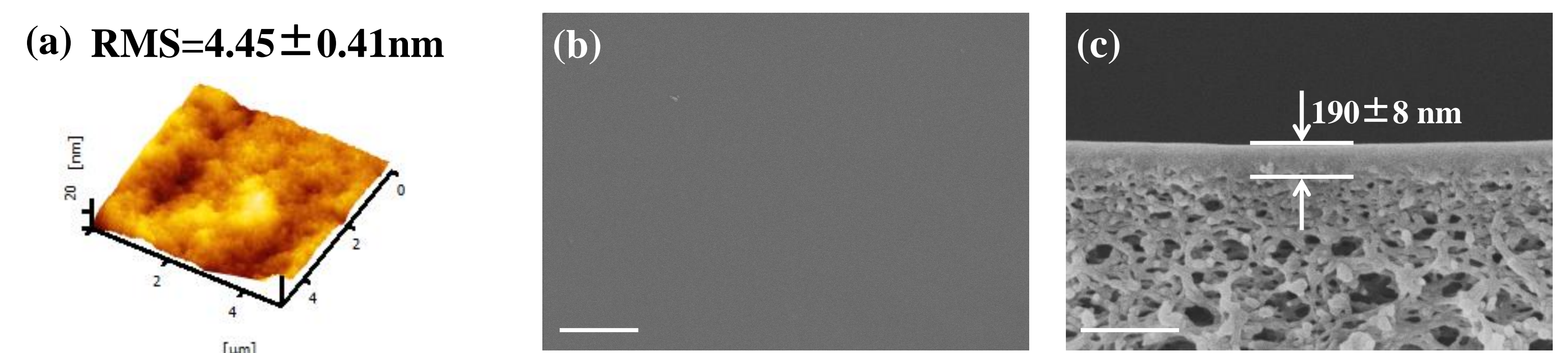


Fig. 3. AFM/FESEM surface micrographs (scale bar: 1 μm) of (a)/(b) M-4; Cross-section of (c) M-4 (scale bar: 500 nm).

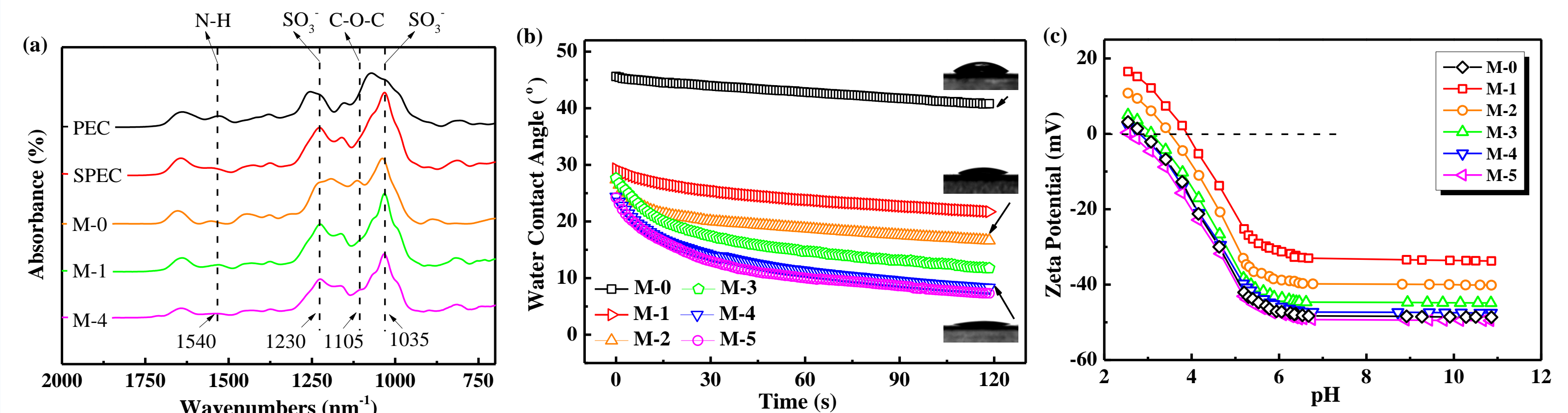


Fig. 4. (a) ATR-FTIR spectra of SPEC, M-0, M-1, M-4 and FTIR spectrum of PEC; (b) Water contact angle of M-0 and SPECMs; (c) Zeta potential varies with pH of M-0 and SPECMs tested with 1.0 mmol L⁻¹ KCl aqueous solution at 25 °C.

Nanofiltration performances of M-0 and SPECMs

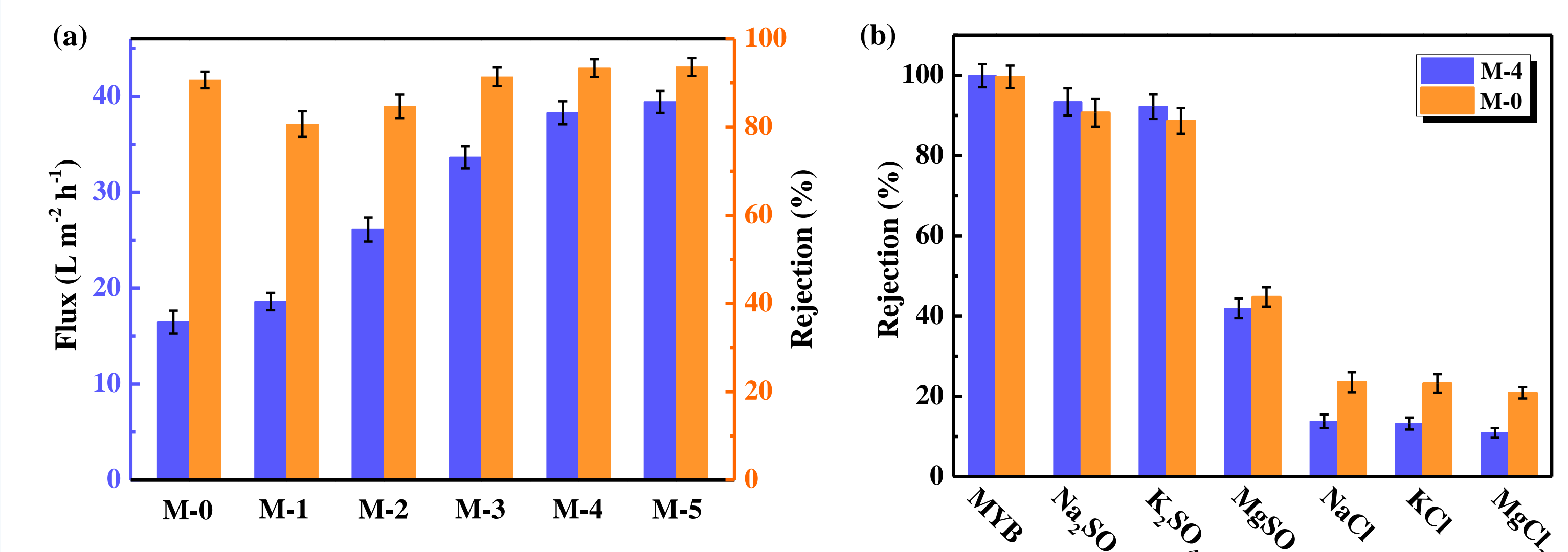


Fig. 5. (a) NF performance of M-0 and SPECMs tested with 1.0 g L⁻¹ Na₂SO₄ aqueous solution and (b) organic dye and different inorganic electrolytes (pH=6.5) at 25 °C under 0.6 MPa.

Dye removal and antifouling properties

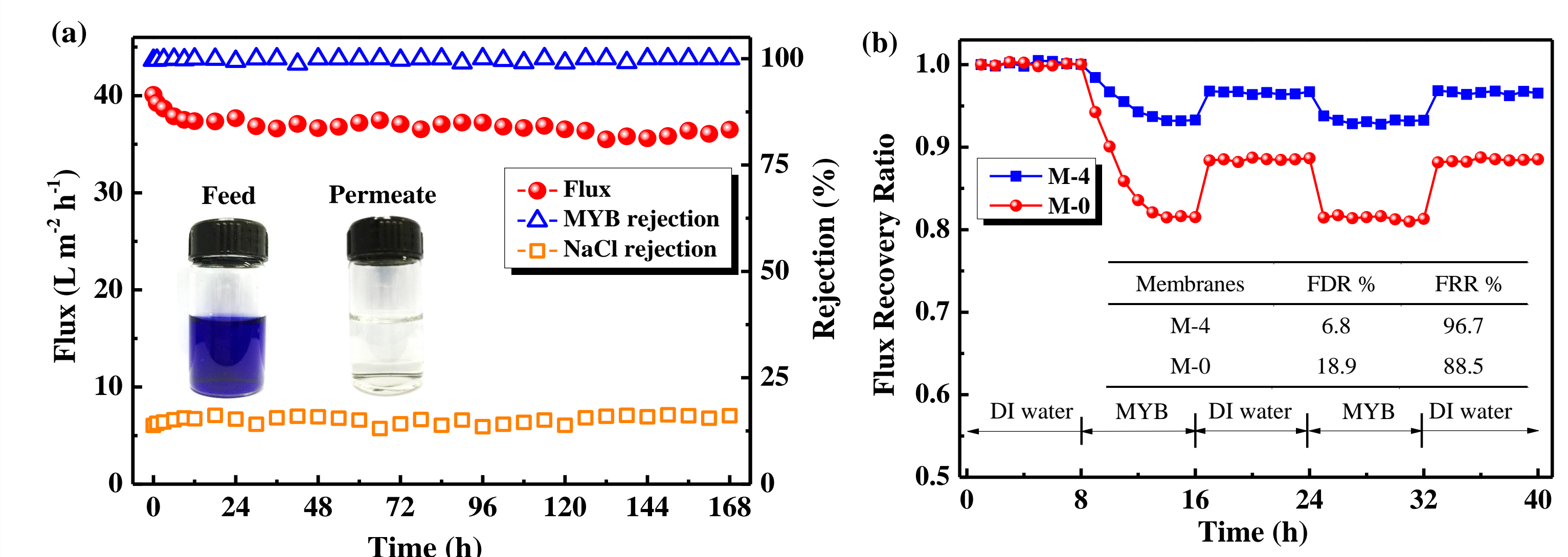


Fig. 6. (a) Time-dependent flux and rejection of 1g L⁻¹ NaCl and 100 ppm MYB solution of M-4 (inset: decolorization effect of M-4) and (b) Flux evolution of M-4 and M-0 tested with 100 ppm dye solution (pH=6.5) at 25 °C under 0.6 MPa (inset: FDR and FRR of M-4 and M-0).

Conclusions

- A novel NF membrane building block SPEC NPs anchored with tunable sulfated groups was fabricated from CS and DSS.
- Hydrophilic PEC NPs reduce transfer resistance and give rise to a fast transport of water molecules, hence render SPECMs with remarkable elevation in water flux and antifouling property.
- The selectivity for NaCl/Na₂SO₄ and NaCl/methyl blue dye were as high as 13.1 and 850, exhibiting good separation performance in a long-term process.

References

1. Q. Zhao, D.W. Lee, B.K. Ahn, etc., Nat. Mater. 15 (2016) 407-412.
2. M. Müller, T. Reihs, W. Ouyang, Langmuir 21 (2005) 465-469.

Acknowledgements: This research was financially supported by National Basic Research Program of China (No. 2015CB655303).