

Preparation and Characterization of Poly (Vinyl Imidazole) Grafted Nanofiltration Membranes

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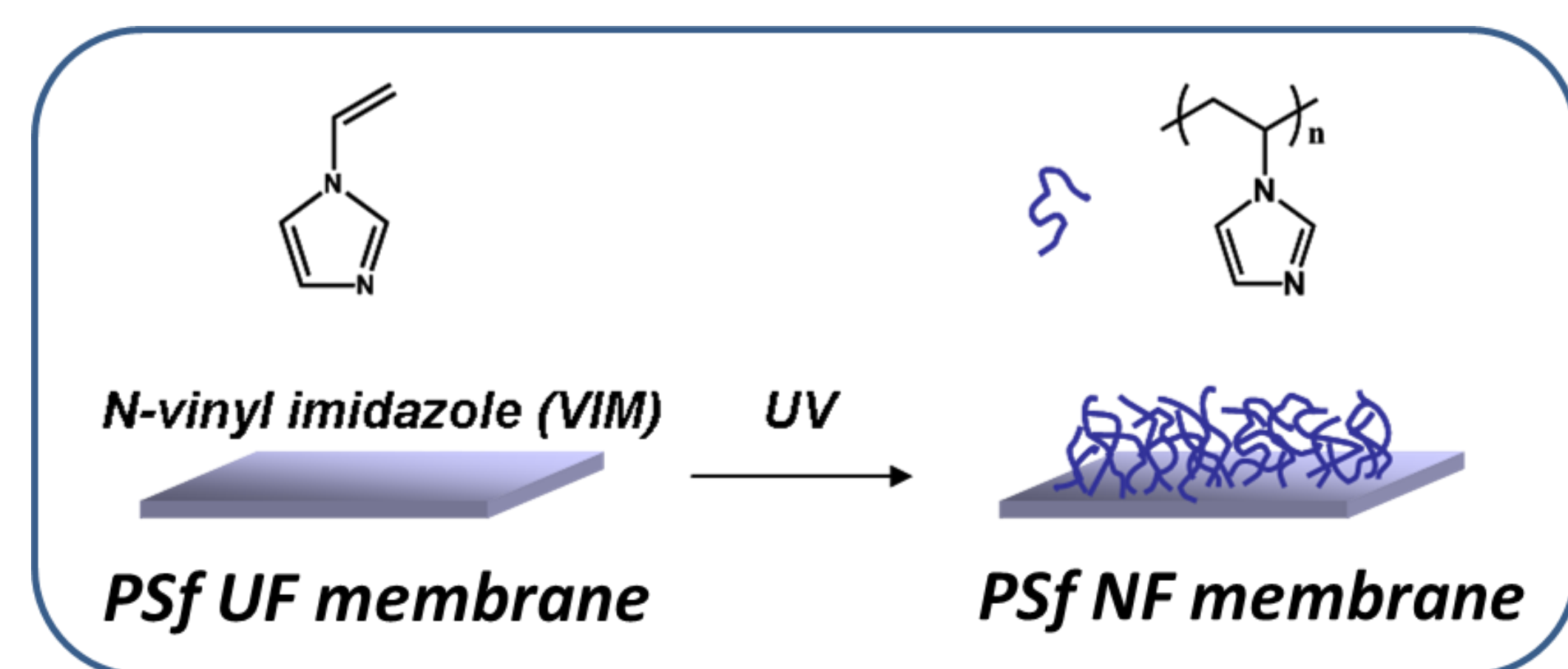
Introduction

Nanofiltration (NF) is a type of pressure-driven membrane-based separation process between reverse osmosis (RO) and ultrafiltration (UF). Due to its low energy consumption, high flux rates, high retention of multivalent ions and small organic solutes such as sugars, natural organic matter (NOM)[1,2].

UV-induced surface grafting has been widely used for preparation nanofiltration membrane with a thin top active layer due to its convenience and versatility. The chemical and physical characteristic of the monomer chosen for grafting is vital importance to the separation performance of the as-prepared nanofiltration membrane.

The current work focuses on preparation of poly vinyl imidazole (PVIM) grafted polysulfone (PSf) nanofiltration membranes (NF) by UV-induced graft polymerization of N-vinyl imidazole. The nanofiltration performance of the resultant NF membranes were evaluated and the results indicate this NF membrane may have potential for textile dye effluent treatment, especially cationic dyes.

Method



Scheme 1. Illustration of the preparation of PSf-PVIM NF membrane.

A UV lamp (wavelength > 300 nm, 100w) was used for photografting N-vinyl imidazole from flat sheet PSf ultrafiltration membrane (MWCO cutoff 70kDa), which were immersed in monomer solution in a Petri dish, then UV irradiations were carried out directly under air atmosphere. Then the modified membranes were washed in ethanol/water several times and stored in DI water.

Results and Discussions

1. Preparation and characterization of PSf-PVIM composite membrane

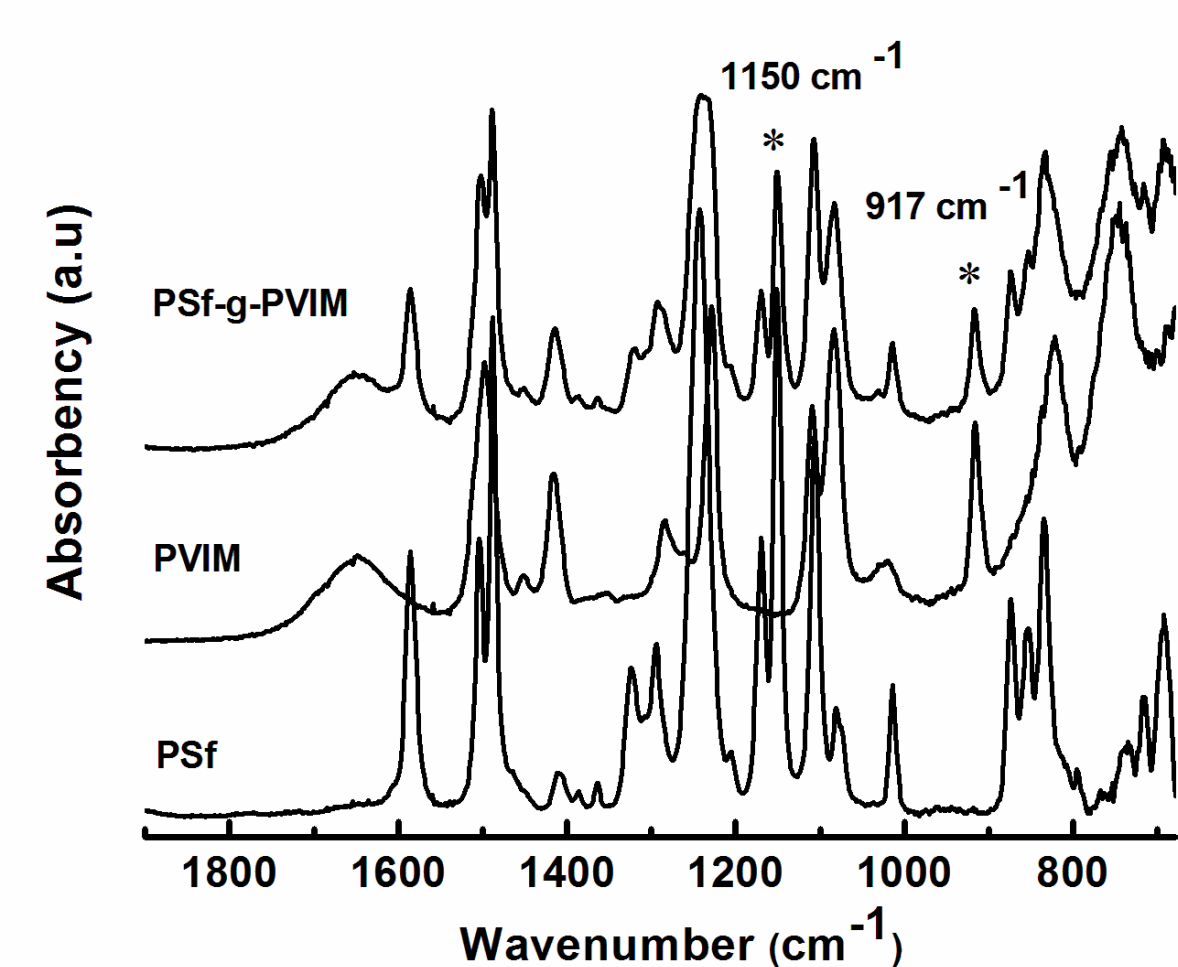


Figure 1. ATR-FTIR spectra of PSf substrate, PVIM homopolymer and PSf-PVIM NF membrane.

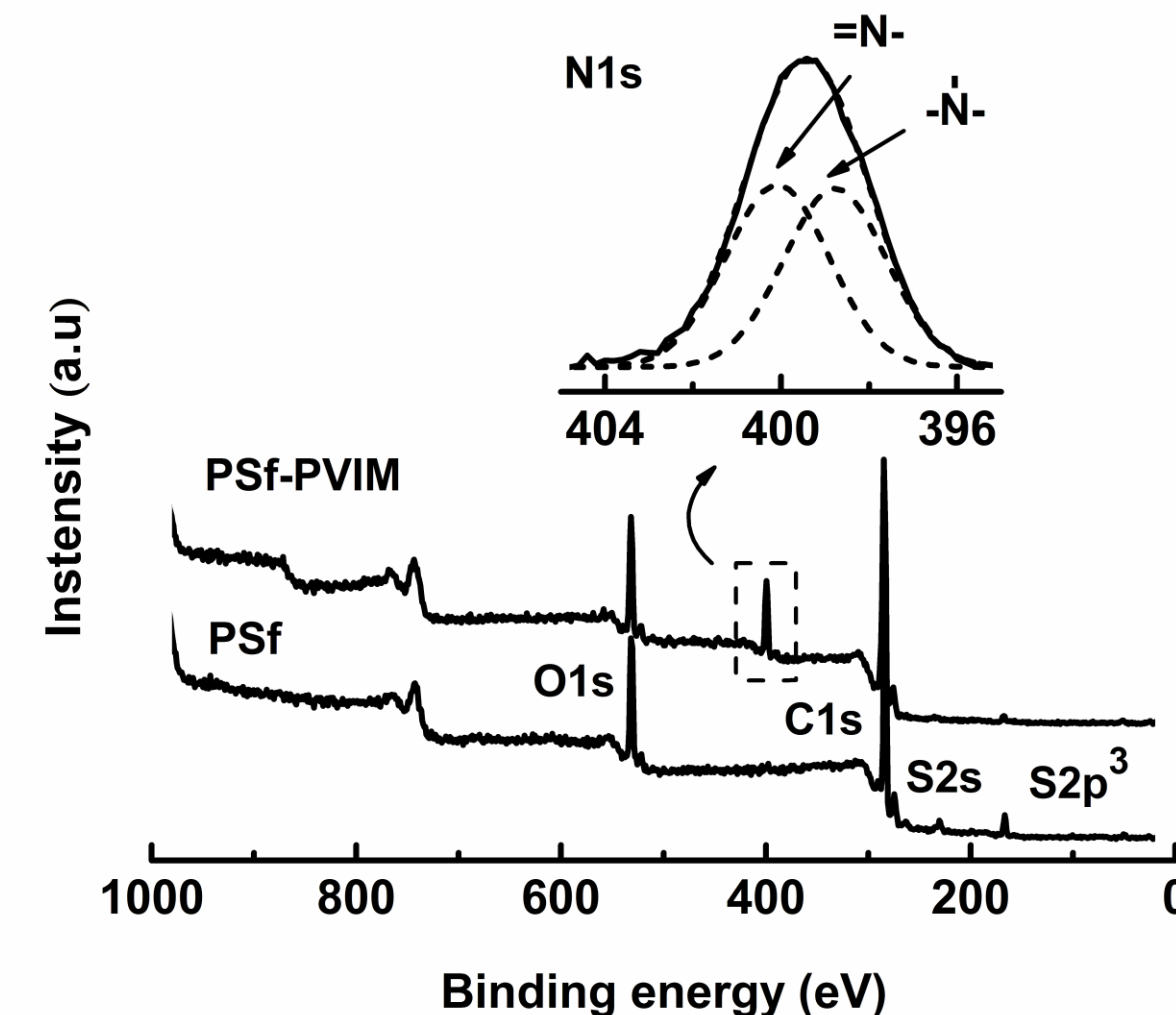


Figure 2. XPS spectra of PSf substrate and PSf-PVIM NF membrane.

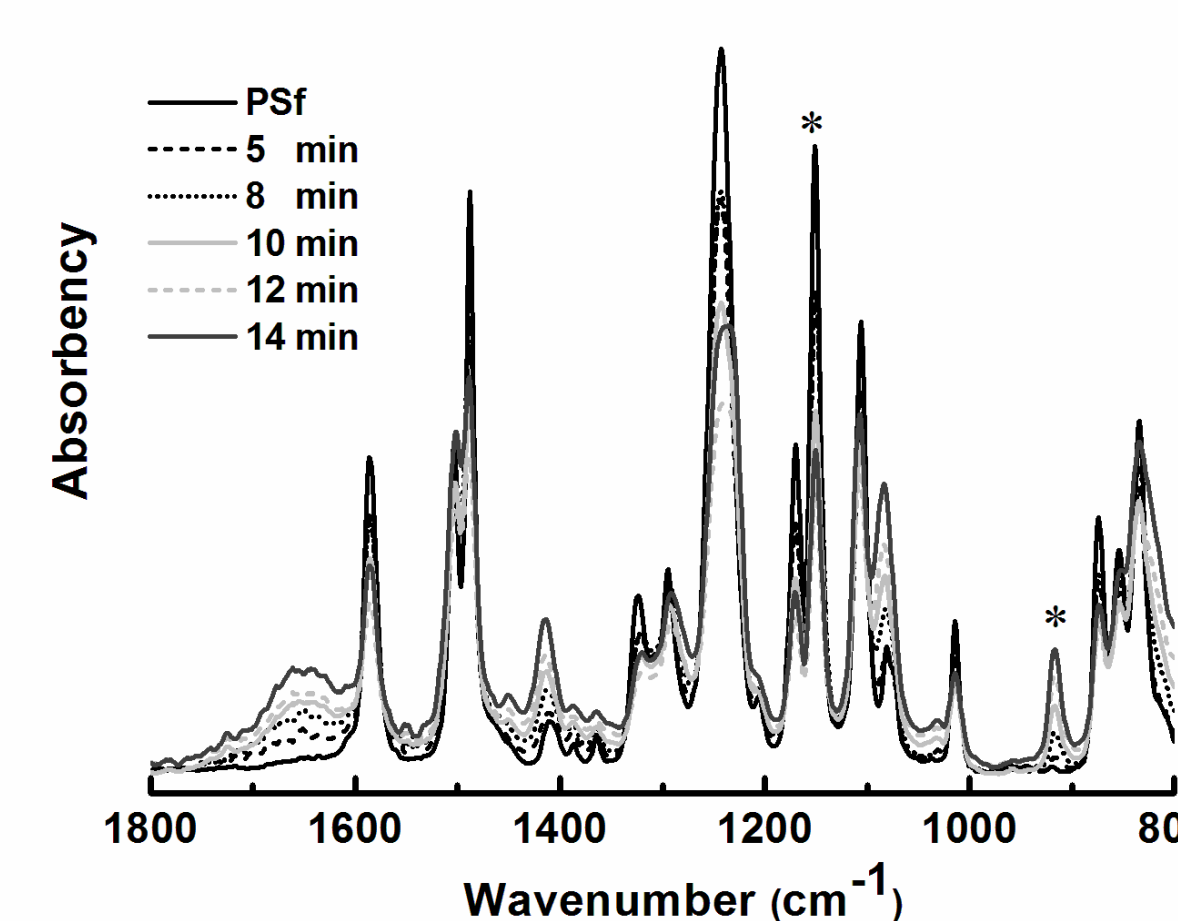


Figure 3. ATR-FTIR spectra of prepared PSf-PVIM composite membrane with different UV grafting time

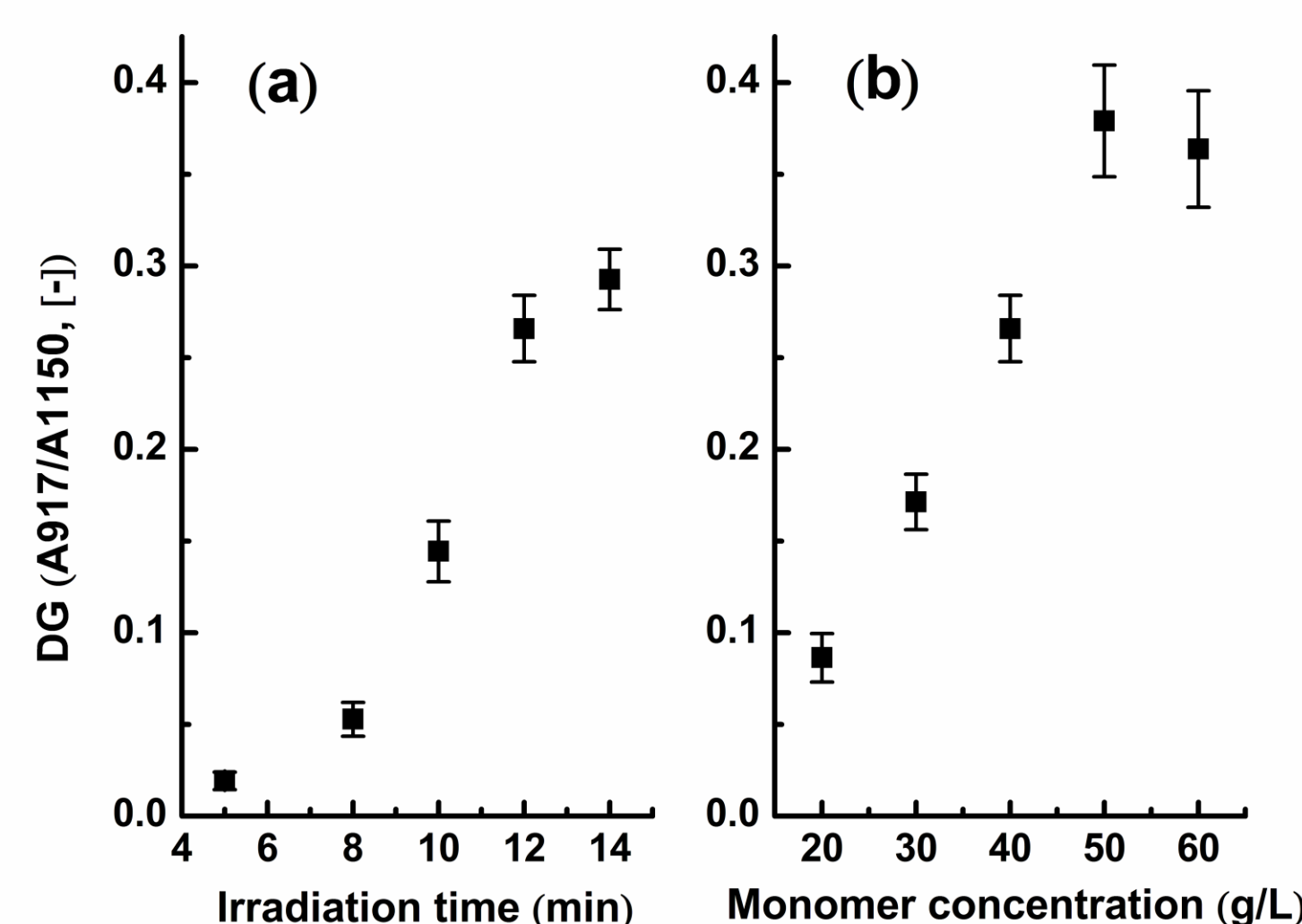


Figure 4. Effect of (a) monomer concentration, (b) UV irradiation time on degree of grafting (DG) defined as the ratio of peak area of 917 cm⁻¹ to 1585 cm⁻¹.

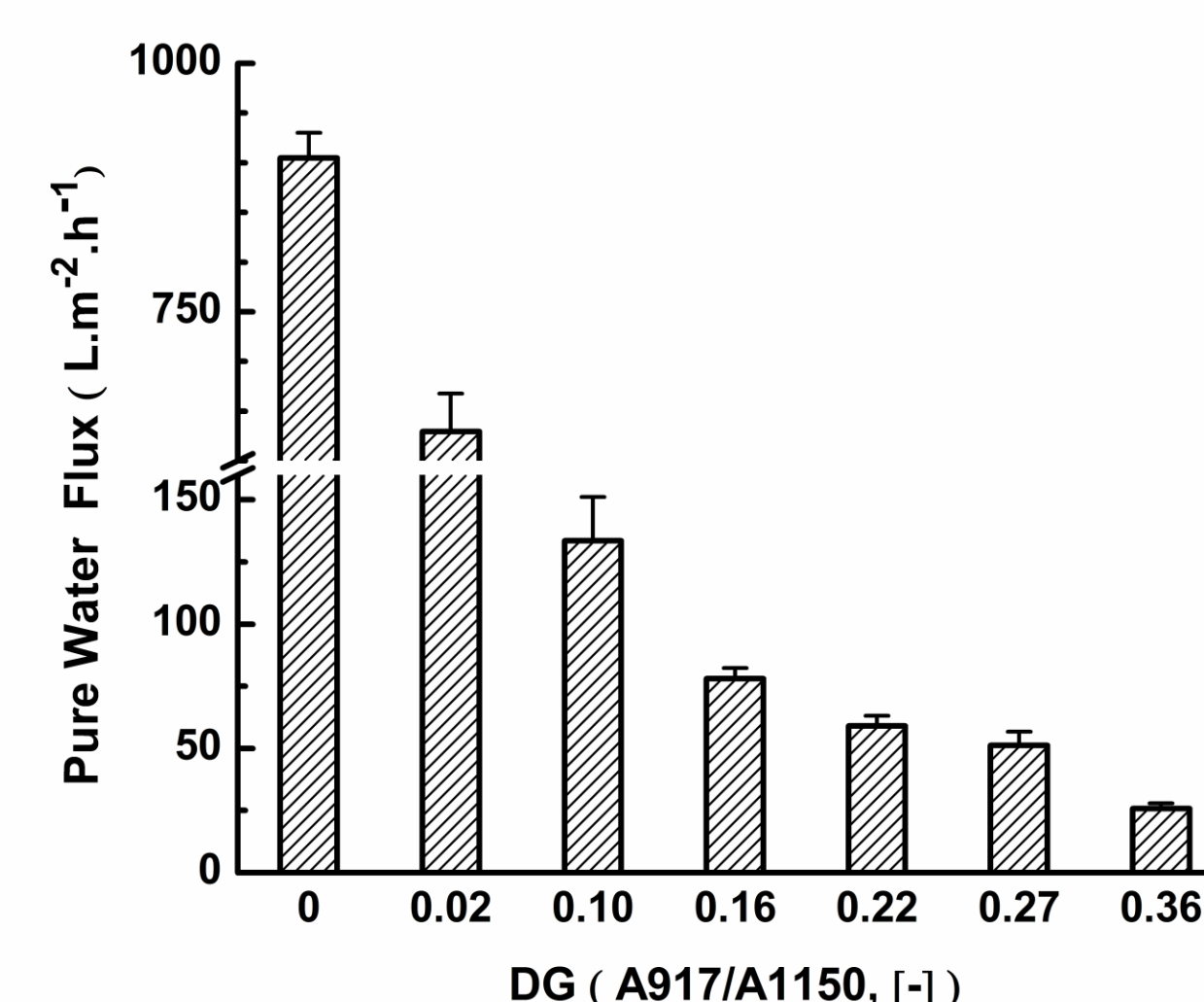


Figure 5. Pure water flux (PWF) of prepared PSf-PVIM composite membrane with different grafting degree (DG).

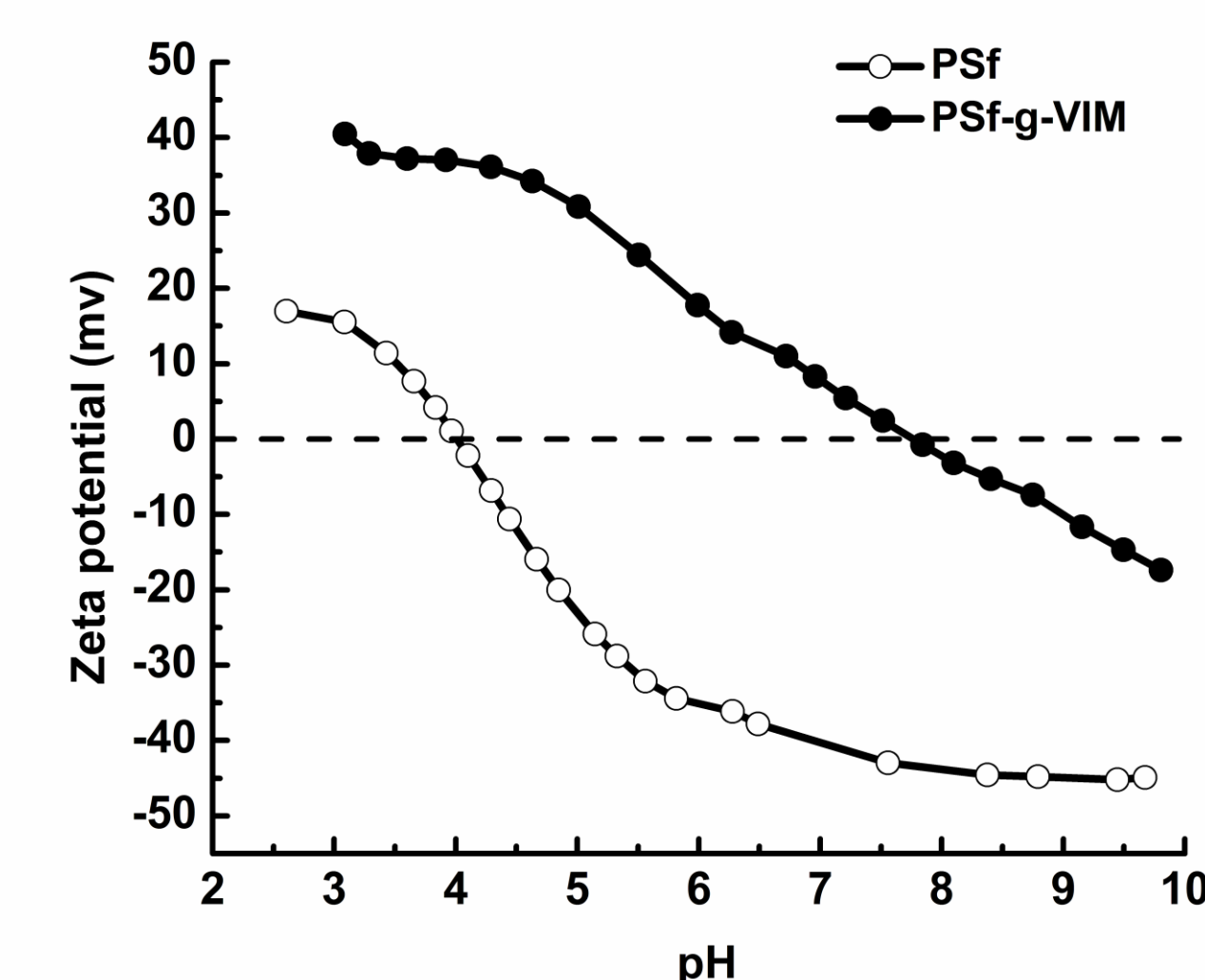


Figure 6. Zeta potential as a function of pH for PSf substrate and PSf-PVIM NF membrane.

2. Nanofiltration performance of PSf-PVIM NF membranes

Table 1. separation performance of PSf-PVIM NF membrane to dye aqueous solution.

dye	Molecular structure	Molecular weight (g/mol)	Charge	molecular diameter (nm)	Rejection (%)
Basic blue 26		506	+1	1.84	>99
Crystal Violet		408	+1	1.72	84.7
Azure B		306	+1	1.48	77.5
Congo Red		697	-2	1.90	>99
Sunset Yellow		452	-2	1.64	42.0

Test conditions: feed dye concentration 25 ppm, operating pressure 0.4 MPa, temperature 25.0 °C and pH 6.2.

Conclusion

Vinyl imidazole monomers were successfully grafted onto PSf UF membranes by UV-induced grafting polymerization. The characterizations of ATR-FTIR, XPS, Zeta potential and pure water flux clearly indicates the formation of poly vinyl imidazole dense layer onto PSf substrates. This active separation layer could efficiently remove cationic dyes based on sieving and Donnan exclusion mechanism, 99% rejection of cationic dye Basic blue 26 (MW 506) was achieved. Meanwhile, the removal of anionic dye Congo red (MW 697) was also reached 99% due to the size exclusion effect.

Acknowledgements

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References

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2. M. Nyström, L. Kaipia, S. Luque, Fouling and retention of nanofiltration membranes, *Journal of Membrane Science*, 98 (1995) 249-262.