Fabrication of High-Flux Asymmetric Polyimide Membrane from Water-Soluble Poly(amic acid) Precursors via an Aqueous Route

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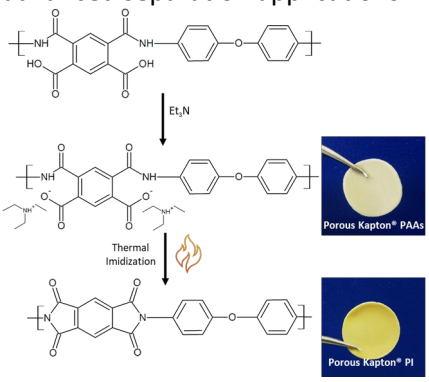
The current membrane manufacturing process relies on traditional solvents such as chloroform, dimethylformamide (DMF), N-methyl-2-pyrrolidone (NMP) and dimethylacetamide (DMAc), which pose significant risks to the environment and human health due to their toxicity and environmental persistence[1],[2]. To address these concerns, the adoption of green solvents as alternatives to conventional ones has emerged as an inevitable trend in membrane fabrication, particularly in non-solvent-induced phase separation (NIPS) and thermally induced phase separation (TIPS) processes[3]. Among these, water stands out as the most sustainable and accessible solvent option. Poly(amic acid) (PAA), a water-soluble precursor to polyimide (PI), offers a viable route for fabricating high-performance membranes in aqueous media[4]. The salt form of PAA, poly(amic acid) salt (PAAS), presents enhanced water processability while retaining the ability to be thermally converted into robust PI structures[5]. In this study, we report a monovalent salt-induced phase separation method to fabricate asymmetric porous Kapton® PI membranes using triethylamine-neutralized PAA. The influence of sodium chloride (NaCl) concentration on phase behavior was examined, and the membranes were prepared via aqueous phase inversion followed by thermal curing. The resulting asymmetric Kapton® membranes demonstrated outstanding thermal and mechanical stability, coupled with remarkably high water flux. Detailed morphological and permeability analyses were conducted to assess performance under varying operational parameters, including applied pressure and temperature ramping, confirming the viability of this sustainable fabrication strategy for advanced separation applications.



Keywords: polyimide membranes, green solvents, aqueous phase inversion, Kapton®.

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