

Amphiphilic copolymer thin-film composite membranes for nanofiltration and pervaporation

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In chemical and pharmaceutical industry, organic solvents are used in nearly every common process. To produce one kilogram of active pharmaceutical products, about 22 kg of organic solvents are used, while less than 50% of the used organic solvents in these processes are recycled. To create more sustainable processes, the recovery and the recycling of used solvents becomes more and more important. Common thermal processes to clean up the organic solvents are high energy consuming. To reduce the energy consumption the general interest in membrane processes is increasing.^[1] Special properties, in particular stability under processes conditions, are necessary for the use in organic solvent nanofiltration or pervaporation. One established material is polydimethylsiloxane (PDMS). Amphiphilic thin-film composite membranes are one class of membranes that show promising, potentially tunable separation performance due to a barrier structure with microphase-segregated morphologies^[2].

Our approach is to explore interpenetrating network (IPN) membranes based on PDMS and poly-(2-dimethylaminoethyl)-methacrylate (PDMAEMA). In order to obtain thin-film composite membranes with tunable barrier structure, a thin PDMS layer is first coated on top of a polyacrylonitrile (PAN) support membrane. In this step, the thickness of the PDMS film and the degree of crosslinking of the PDMS network can be varied. In a second step, the PDMS membrane is placed in a solution of DMAEMA monomer, a cross-linker monomer and a photo-initiator, followed by cross-linking copolymerization activated via UV irradiation.^[3] To further promote phase microphase separation in the IPN, the PDMAEMA can be functionalized to a polyzwitterion via sulfobetainization using propane-1,3-sultone in a third step.^[3]

The feasibility has been demonstrated using a commercial PDMS composite membrane (Pervap 4060, DeltaMem AG) which had been converted into a PDMS-PDMAEMA-IPN composite membrane. Nanofiltration data for different organic solvents indicate that the formation of the amphiphilic IPN leads to changed barrier

properties because the permeability of non-polar hexane is largely reduced while that of polar isopropanol is increased (Figure 1). Ongoing work is devoted to variations of the PDMS layer and IPN structure as outline above, and the evaluation of the novel membrane with respect to permeance and selectivity in separation of mixtures by nanofiltration or pervaporation.

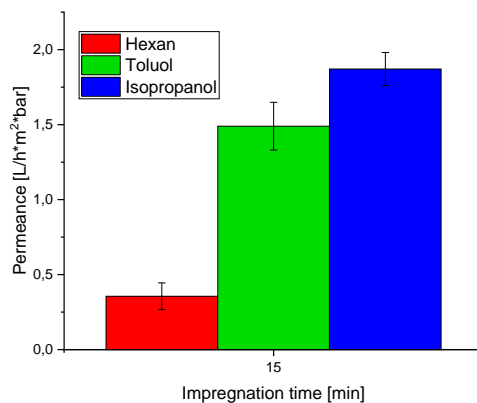


Figure 1: Nanofiltration permeances for different organic solvents of a novel PDMS-PDMAEMA-IPN membrane and the precursor PDMS membrane.

References

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