STATE OF THE ART for MOLECULAR SIEVE COMPOSITE MEMBRANES

To overcome the fundamental limitation of conventional membranes, the current research is focused on synthesizing and evaluating novel membranes. One of the most promising approaches has been the addition of micro-porous molecular sieving materials (e.g., zeolites, silica and carbon molecular sieves) to organic polymers in the hope of combining the processability of the polymers with the strong size selectivity of spatially well-defined inorganic pores. Since zeolites and carbon molecular sieves have highly attractive permeation properties, with permeabilities and selectivities significantly higher than polymeric materials, the size- and shape-selectivity of these nanoporous materials would be expected to generate precise molecular sieving discrimination by permitting smaller-sized gas penetrants to diffuse at much higher rates than larger-sized penetrants. Composite materials exploiting the mass transport properties of polymer matrices, and nanoporous complexes, may lead to membranes with enhanced gas separation properties.
However, the preparation of novel membranes containing molecular sieves has been hampered by difficulties in forming continuous, defect-free membranes due to poor polymer/molecular sieve adhesion and inadequate particle dispersion.\cite{8b} For example, the permeabilities of various gases through zeolites and/or carbon molecular sieves embedded in rubbery polymer composite membranes\cite{11c} have only demonstrated small increases for the fast gas penetrants (e.g., O\textsubscript{2} and CO\textsubscript{2}), and decreases in the permeabilities of slower gas penetrants (e.g., N\textsubscript{2} and CH\textsubscript{4}). This low increment in the fast-gas permeability properties of rubbery polymer are attributed to the rubbery polymers, which have faster gas permeabilities than the more selective carbon and zeolite sieves. Theoretical predictions have revealed that higher permselectivities are expected in glassy polymers such as polyimide.\cite{10, 11a, 12} However, zeolite-polyimide membranes have exhibited poor polymer-sieve contact due to the high chain rigidity of polyimide.\cite{13} It has been postulated that this rigidity disturbs the usual close packing of the polymer chains in the vicinities around the zeolite particles, resulting in voids in the mixed matrix membrane. The overall selectivity is therefore no better than the polymer alone due to the gas penetrants bypassing the sieves. The polymer matrix, while supporting the molecular sieve phase, has to connect the surface to the porous substructure, which can conveniently be the materials having similar properties to promote miscibility.

Lots of coupling agents have been employed to enhance the adhesion between the molecular sieve and the polymer matrix to eliminate the formation of interfacial voids.\cite{14, 15} However, the improvements in permselectivity were negligible, despite indications of good coupling between the agent and the zeolites (or carbon molecular sieves). The inability to create membranes with superior performance is likely to arise from any one of a number of factors, notably inappropriate matrix or molecular sieve materials, or the failure to eliminate structural defects. Consequently, the development of a new sieving material which exhibits a strong adhesion with the organic polymer matrix, as well as well-controlled molecular sieving characteristics, would prove beneficial in applications such as gas separation.

**STRUCTURE OF POLYSULFONE**

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CONFIRM THE CHAIN STRUCTURE OF COMPOSITE MEMBRANES

In dense organic membranes without the presence of a porous complex, gas molecular transport through the membrane is dependent on the amount of free volume (i.e., a space not occupied by polymer chains), related to the d-spacing between the polymer chains which can be measured using wide angle X-ray diffractometry. Here, the chain structure of pristine PSf, complex, and PSf-nanoporous composite films were measured and the structures were determined to be unchanged after loading of the porous complex.

Waxs Graph
