Poly(ionic liquid)/ionic liquid ion-gel membranes for CO_2/light-gas separations

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The main focus of this talk is the development of a new poly(ionic liquid)/ionic liquid (PIL/IL)-based membrane materials platform (Figure 1) that has the potential to reduce the cost of post-combustion CO_2 capture from coal-fired power plants to meet the U.S. Department of Energy performance targets. This talk will illustrate how blending PILs and ILs can produce physically stable PIL/IL ion-gel composite materials that have CO_2/N_2 separation properties (CO_2 permeability up to 500 barrers; CO_2/N_2 selectivity up to 35) better than most conventional polymer membrane materials. These materials have been fabricated as 100-nm-thick defect-free active layers on a porous support. The resulting membranes display CO_2 permeance of up to 6100 GPU and a CO_2/N_2 selectivity of 22. We also present methods for chemically and structurally modifying the PIL/IL ion-gel platform as a means of optimizing CO_2/N_2 separation properties (Figure 1). These methods include the development of cross-linkable PILs that allow the inclusion of higher amounts of IL to produce membranes with a CO_2 permeability of up to 600 barrers; the inclusion of fixed-site facilitated CO_2 transport groups that produce membranes with a CO_2 permeability of up to 900 barrers and a CO_2/N_2 selectivity of up to 140 (at low CO_2 partial pressures and high relative humidity); and mixed-matrix ion-gels that contain microporous solids that produce membranes with CO_2/CH_4 selectivities of up to 90. The CO_2/N_2 separation performance ranges of these PIL/IL ion-gel materials are visually compared in a Robeson plot (Figure 2) relative to typical membrane materials and the empirical 'upper bound' line that represents the best existing membrane materials.

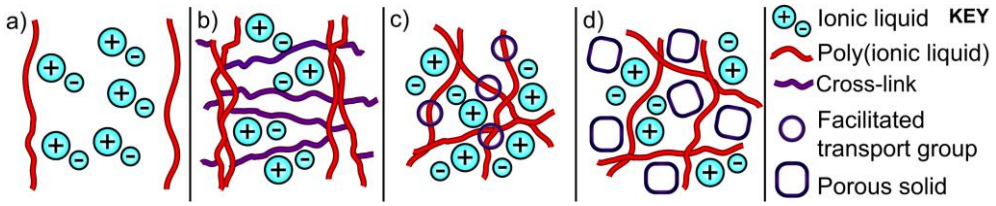


Figure 1. The range of membrane materials that have been developed from the PIL/IL ion-gel platform: a) Linear PIL/IL ion-gels (prepared as 100-nm-thick active layers); b) Cross-linked PIL/IL ion gel materials with improved *CO_2 permeability*; c) PIL/IL ion-gels that incorporate facilitated transport groups to improve *CO_2 permeability* and *CO_2/N_2 selectivity* at low CO_2 partial pressures; and d) Mixed-matrix membranes (MMMs) that incorporate a microporous solid incorporated into the PIL/IL ion-gel platform to improve *CO_2 permeability* and *CO_2/light gas selectivity*.

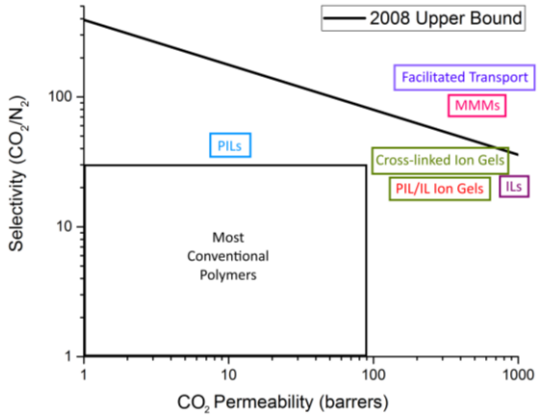


Figure 2. A Robeson plot showing the performance of the PIL/IL ion-gel materials as compared to typical membrane materials and the 2008 'Upper Bound', which represents the best CO_2/N_2 gas separation membranes.