**Introduction**

- Ionic liquids (ILs) are attractive materials for gas separation due to their CO₂ selectivity over light gases, low vapor pressure, and tunable properties. Polyethylene oxide (PEO) is also an attractive material for gas separation membranes due to its high CO₂/light gas solubility selectivity. Immobilizing ILs into polymers as ion gel membranes increases the gas permeability of the polymer.

- A series of free-standing ion gel membranes have been prepared with PEO cross-linked polymers and a variety of commercial ionic liquids to explore the cation and anion effect on the ion gel phase miscibility and CO₂/N₂ separation performance.

- A second series of ion gels were prepared utilizing the IL-PEO interaction to design miscible ion gels with excellent CO₂/N₂ gas separation properties.

**Film Fabrication**

We mixed the ionic liquids (40 vol%) directly into the monomer mixture and exposed the reaction mixture to UVA (365 nm) irradiation to afford ion gels within a minute.

**Ionic Liquids**

**Commercial Series:** Screening cations and anions for polymer compatibility

- Most stable ion gels were completely amorphous cross-linked polymers.
- Tg with IL incorporation is due to plasticization/reduction in cross-link density.
- Melting transitions are due to phase-separated ILs.

**Functionalized Series:** Synthesized based on compatibility of commercial series and for improved gas transport

**Evaluation of IL/polymer compatibility**

- Ion gel films with the best IL-polymer compatibility are transparent and completely dry.
  - The "greasy paper" test: observing IL wicking onto a dry, porous surface
  - Oily surface obtained for ILs lacking compatible anions
  - Aromatic cores gave dry films paired with [Tf₂N]- anion
  - Paired with [Tf₂N]+ cation
  - Completely dry film obtained with 40 vol% [emim][Tf₂N] or [emim][dca]
  - [emim][acetate] is immiscible with monomer

**Film Separation**

- All films were transparent, dry ion gel membranes.
- IL incorporation increases the gas permeability and CO₂/N₂ selectivity.
- Property averaging reduced CO₂/N₂ selectivity for [Tf₂N] ILs while [emim][dca] maintains high selectivity.

**DSC for Evaluating Ion Gel Stability**

- The interaction of IL cation and anion with PEO determined the ion gel miscibility.
- Less basic anions (i.e. Tf₂N, dca) and aromatic cations (imidazolium or pyridinium) provided dry, amorphous ion gel membranes.
- IL-PEO compatibility was used to synthesize functionalized imidazolium Tf₂N ILs that were incorporated into high performance ion gels with excellent phase stability, high gas permeability, and good CO₂/N₂ selectivity.

**Conclusions**

- Most ILs have CO₂ permeability less than [emim][Tf₂N] gel.
- CO₂/N₂ selectivity is best for nitrile and oligoethylene glycol functionalized ILs.