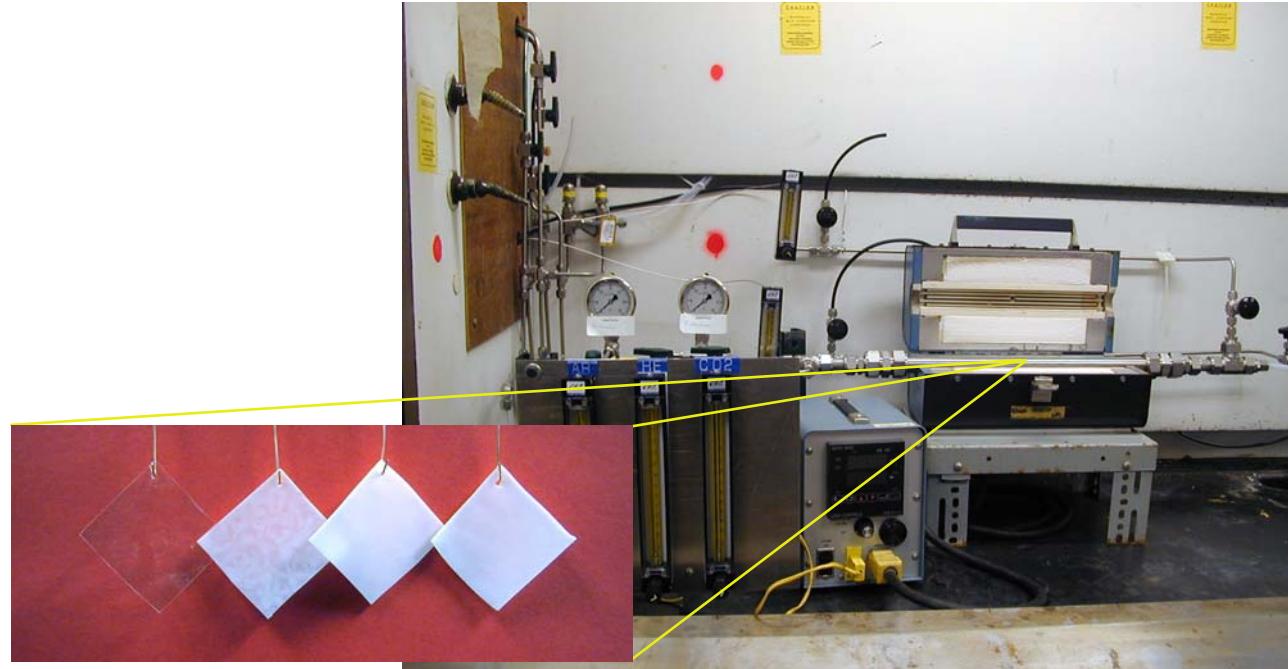


Supported Ionic Liquid Membranes for Carbon Dioxide Separation



David Luebke, Jeffery Ilconich, Christina Myers, Henry Pennline

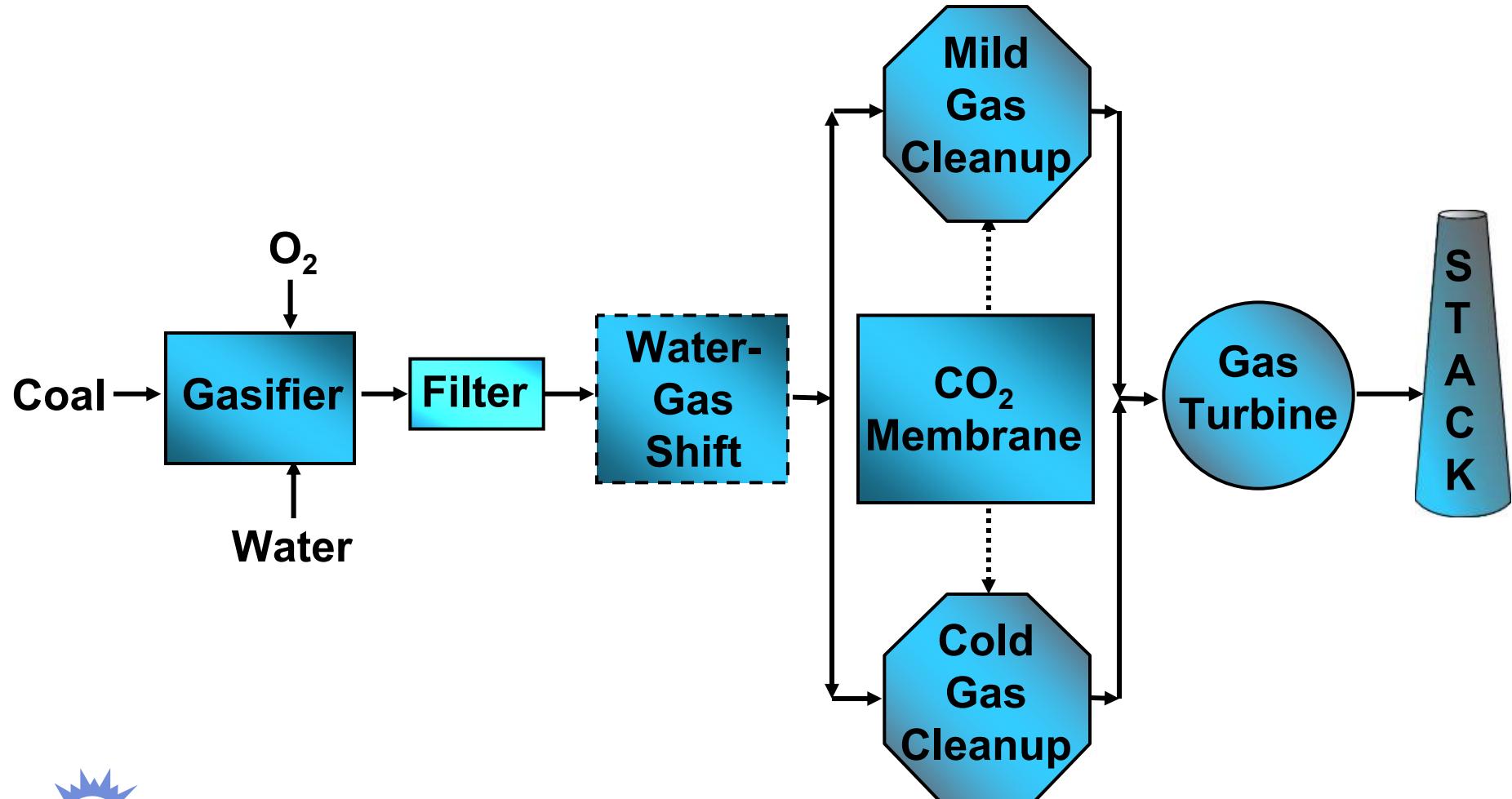
May 9, 2006



5th Conference on Carbon Capture & Sequestration

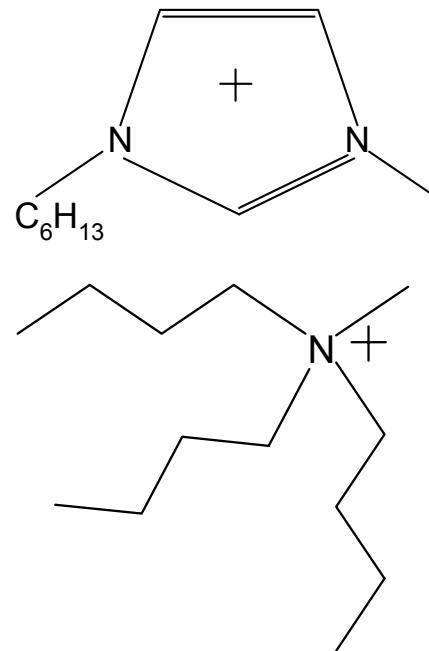
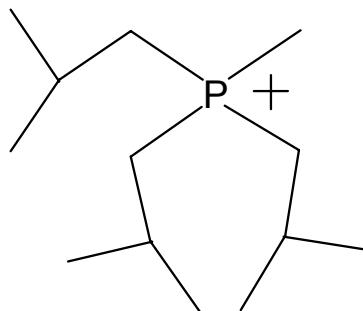


Precombustion CO_2 Capture in IGCC

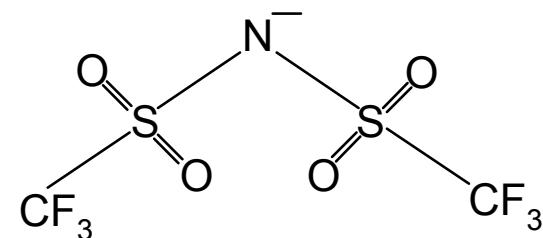
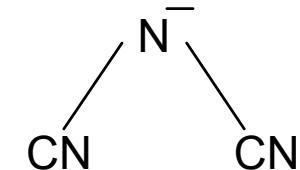
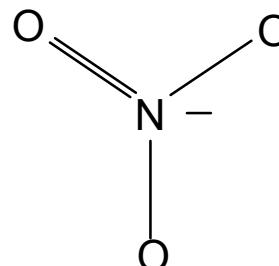


Potential of Ionic Liquids

Cations

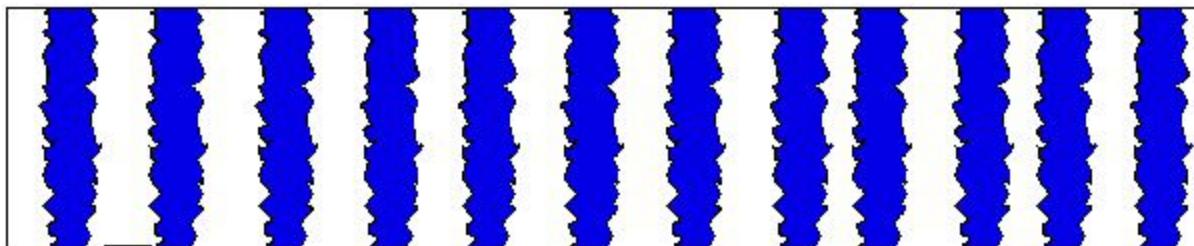


Anions

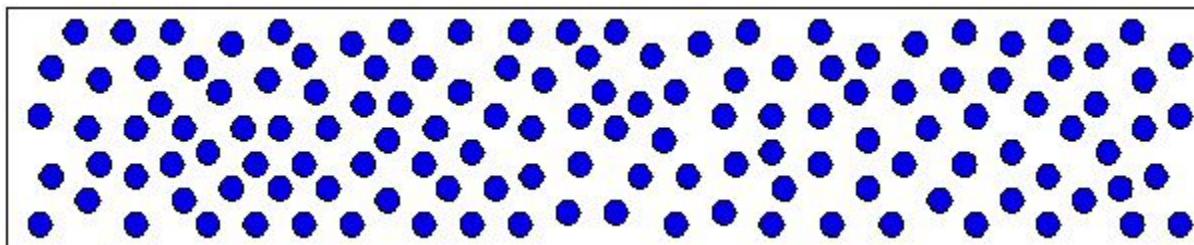


- Negligible Vapor Pressure
- Thermally Stable above 200°C
- High CO₂ Solubility Relative to H₂, N₂, and CH₄

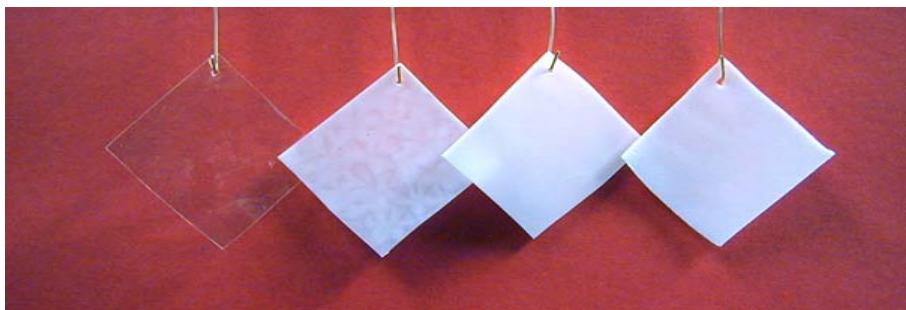
Several Fabrication Options



Porous Substrate



Dense Substrate



Selection of Support Material Significant

PES Support-Supor®

- Suggested by Noble et al. as a useful support*
- $T_g \sim 210^\circ\text{C}$
- Visible change when heated to 100°C in the presence of $[\text{hmim}][\text{Tf}_2\text{N}]$
- Membrane failure occurs at less than 50°C

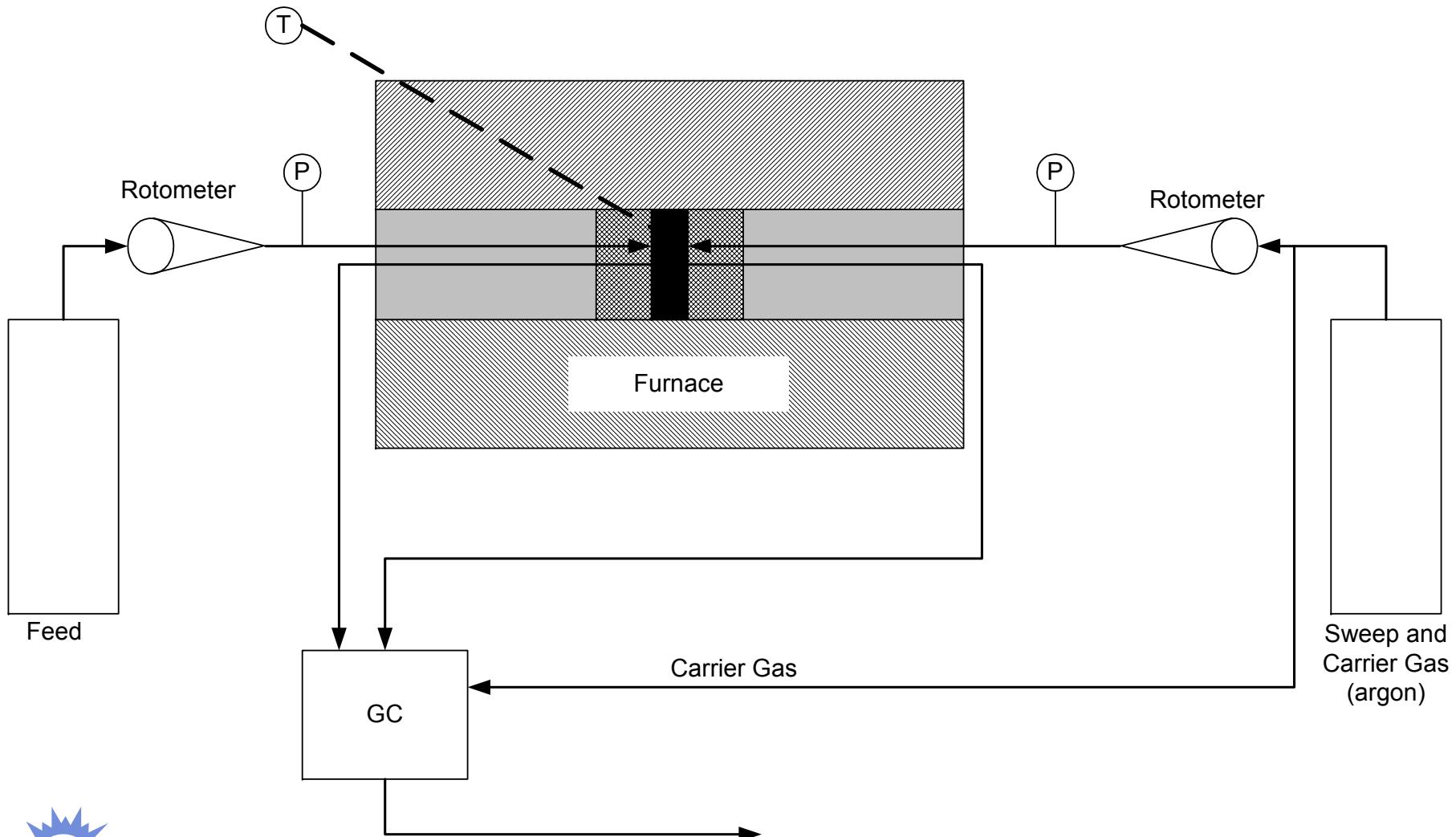
PSF Support-HT Tuffryn®

- Unmodified $T_g \sim 150^\circ\text{C}$
- Membrane stable to 125°C

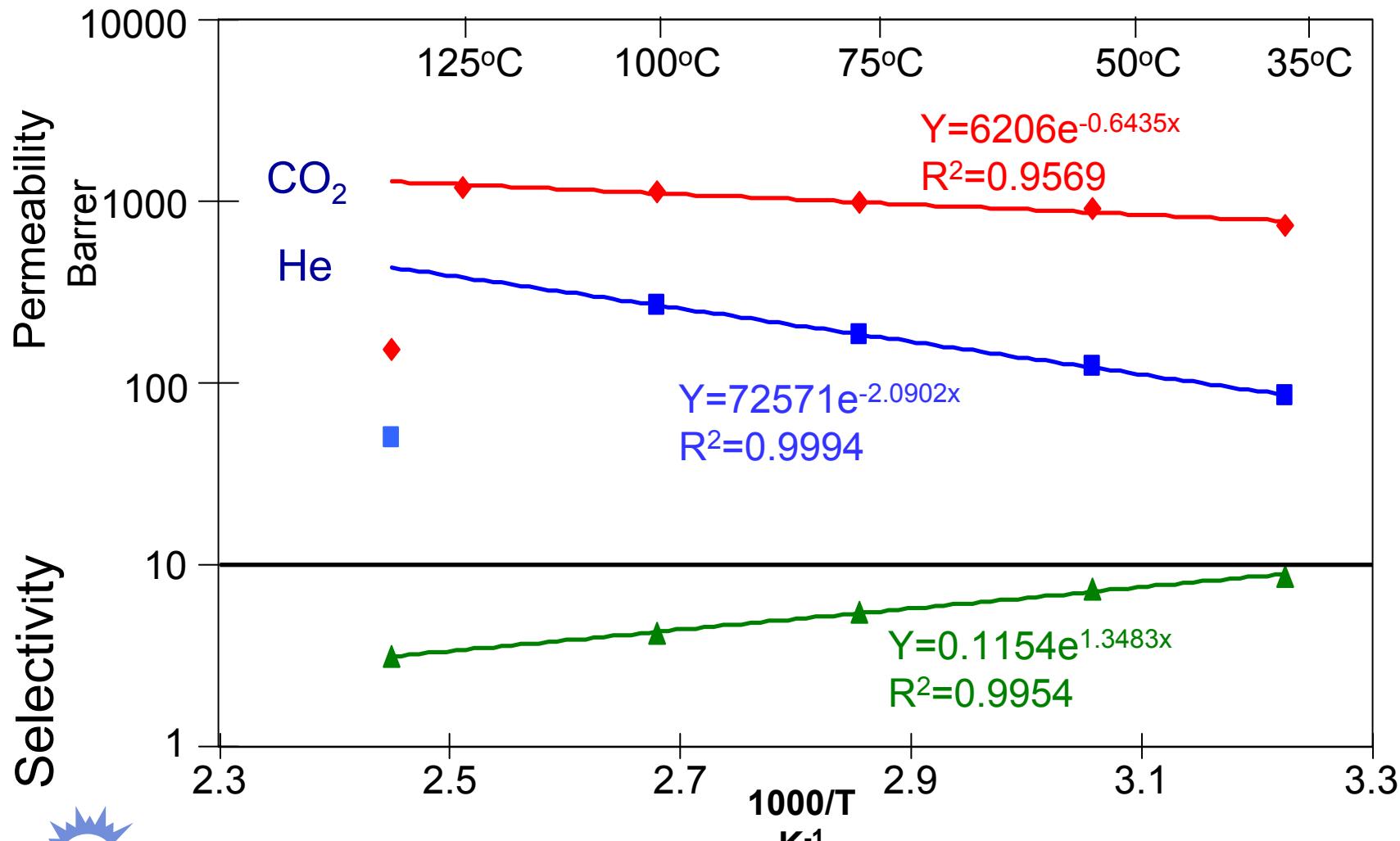


*Scovazzo et al. in: R. Rogers, K. Seddon (EDS.) *Industrial Applications of Ionic Liquids*, American Chemical Society Books, 2002, Chapter 6.

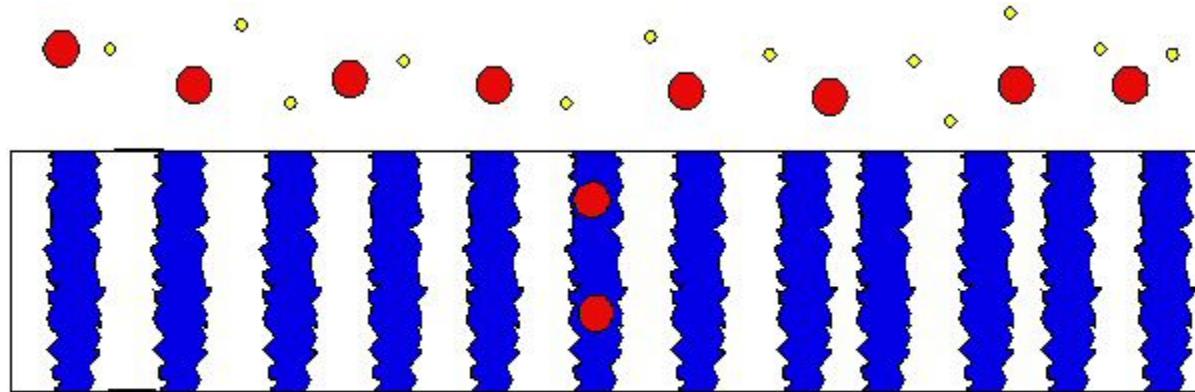
Constant Pressure Flux Measurements



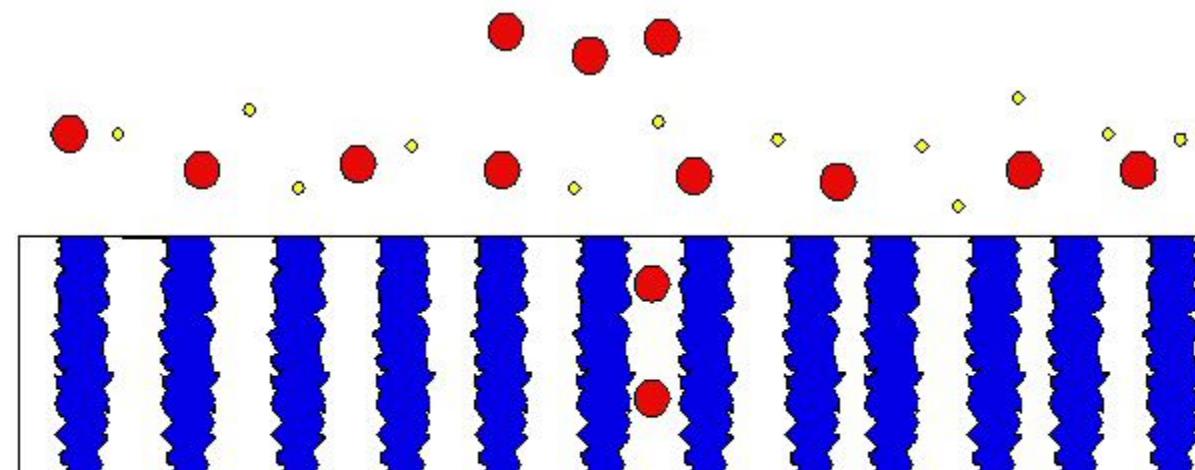
Support Failure Limits Performance



Other Mechanisms Inconsistent

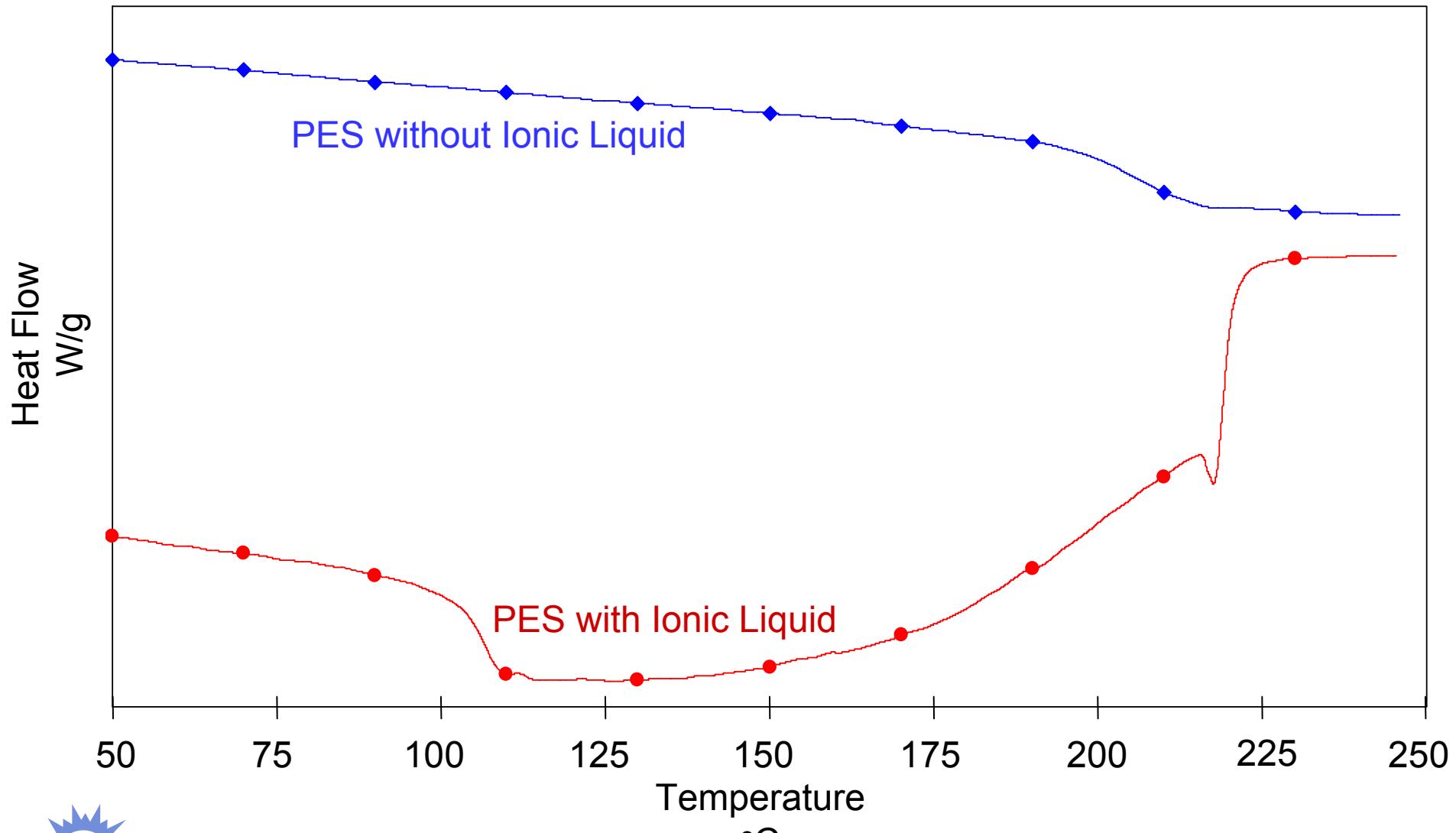


Original
Mechanism

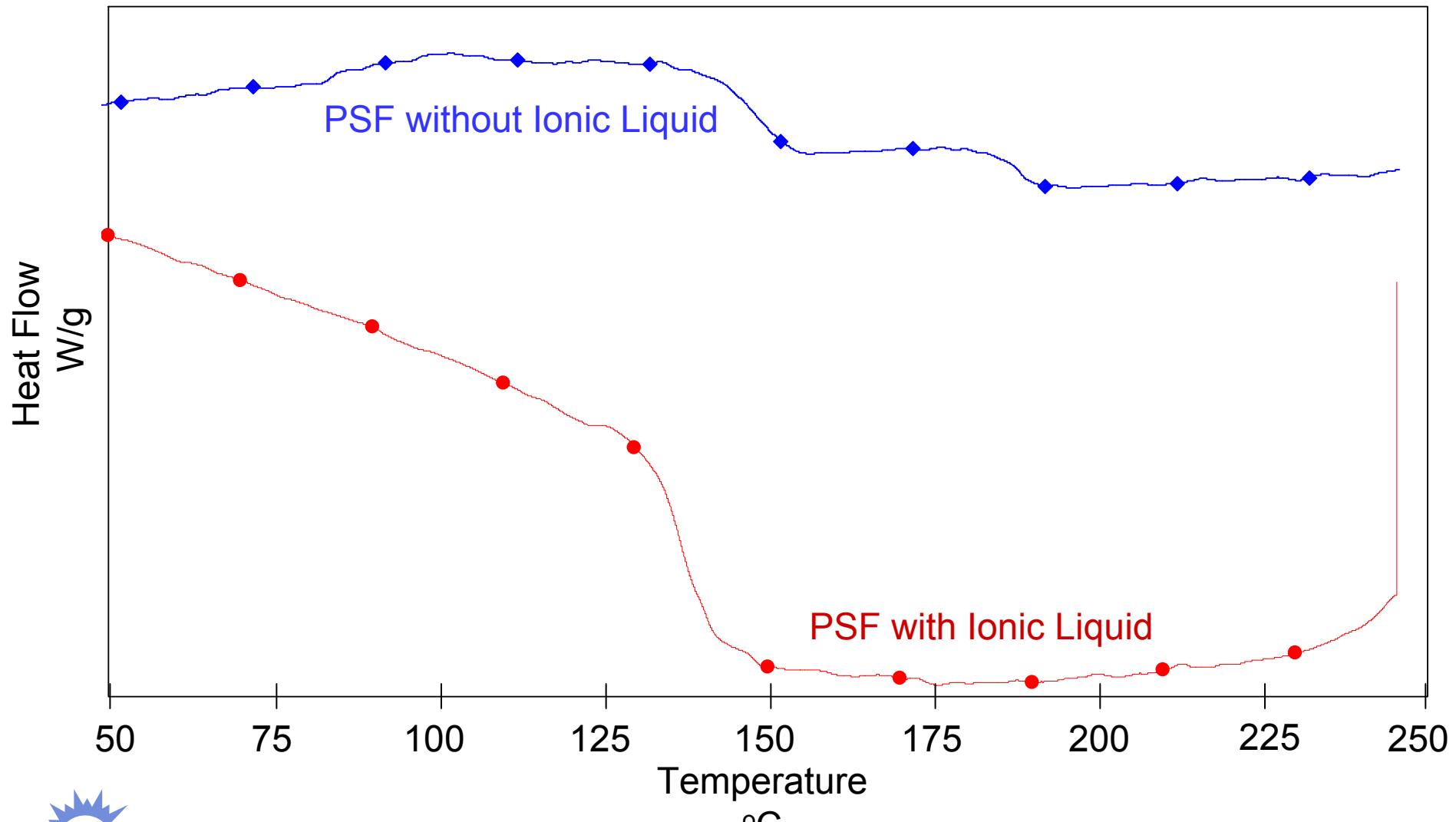


New
Desorption
Mechanism

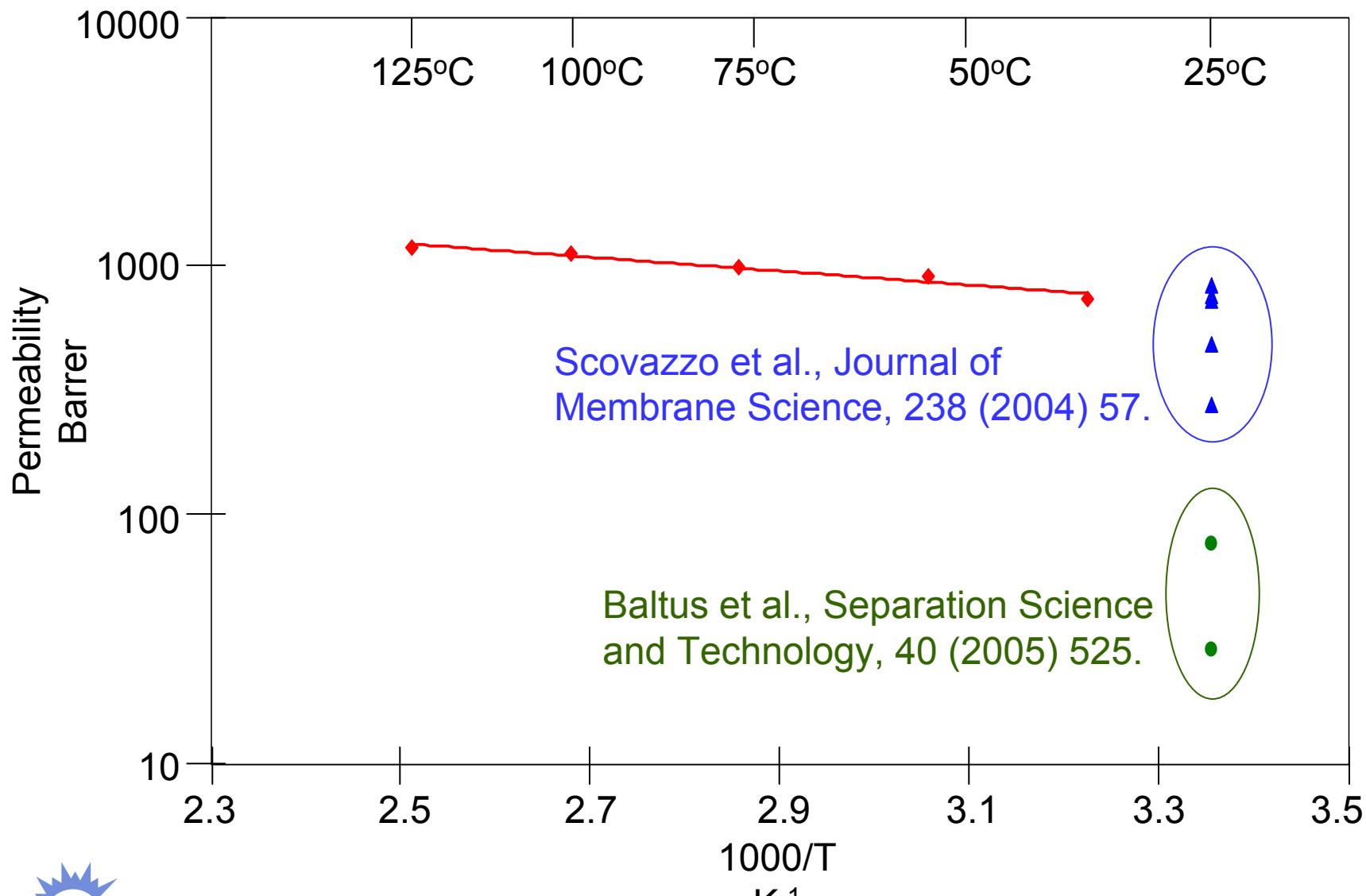
DSC Confirms Large T_g Reduction for PES



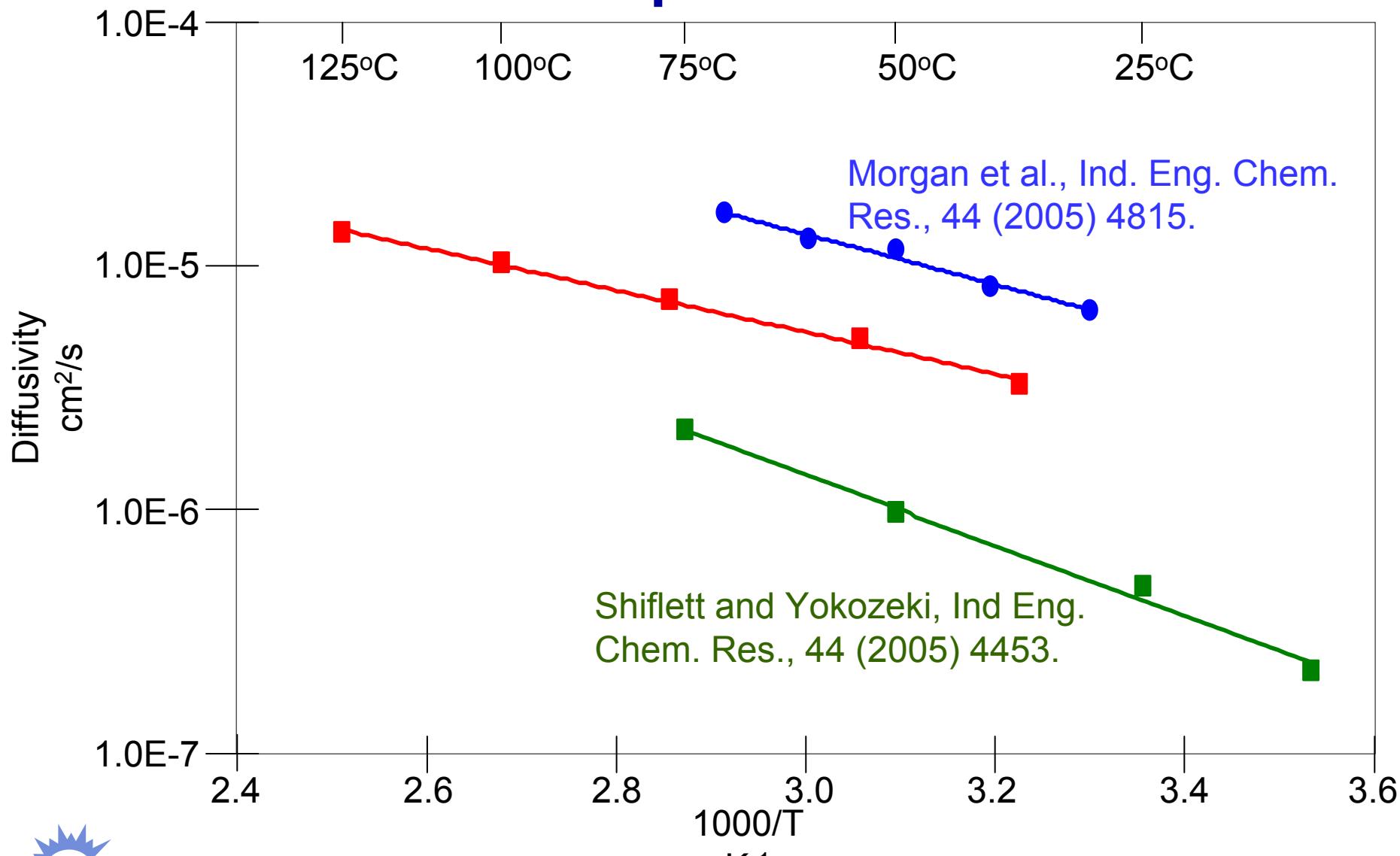
PSF Less Affected



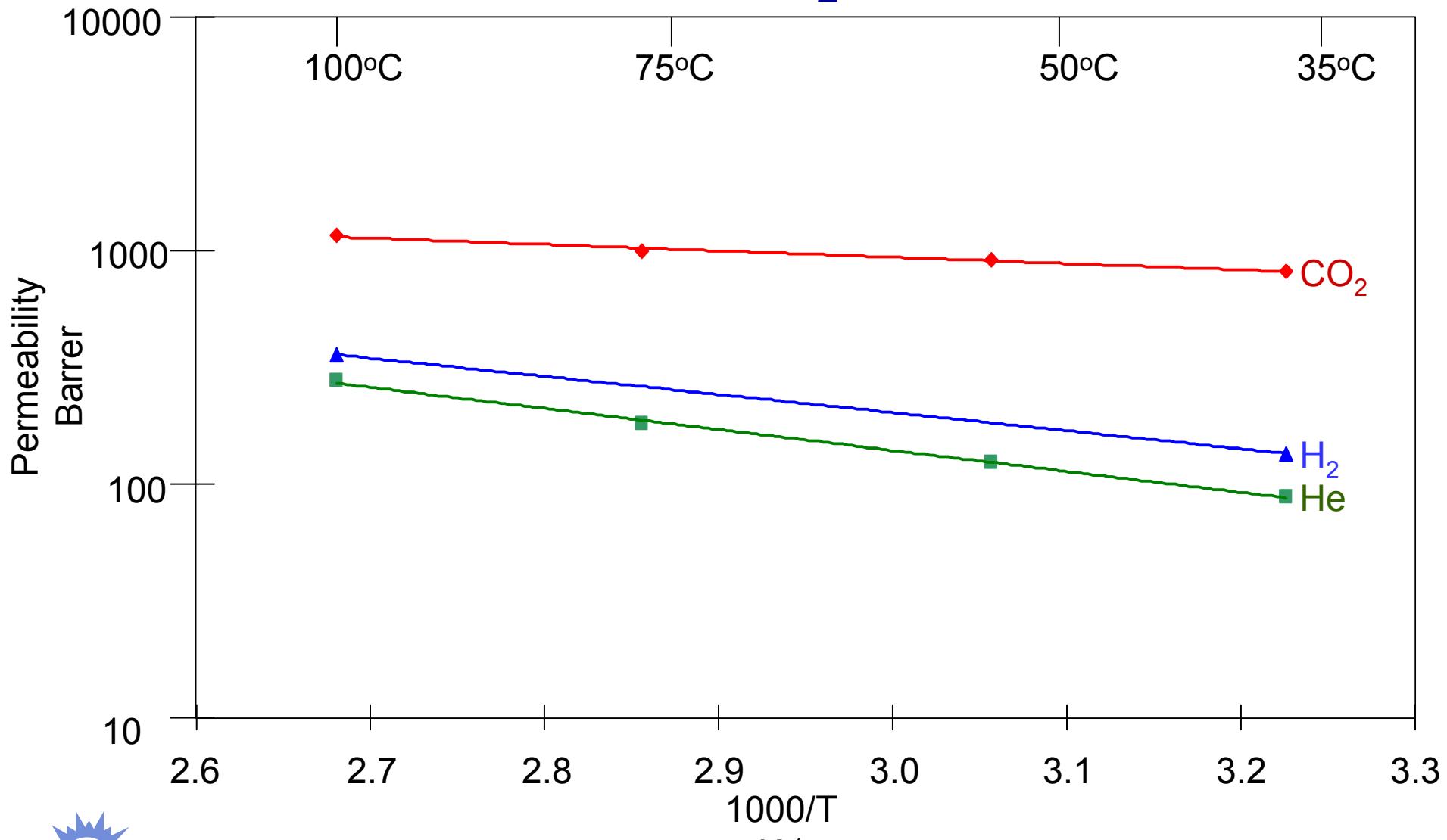
Permeabilities Similar to Literature



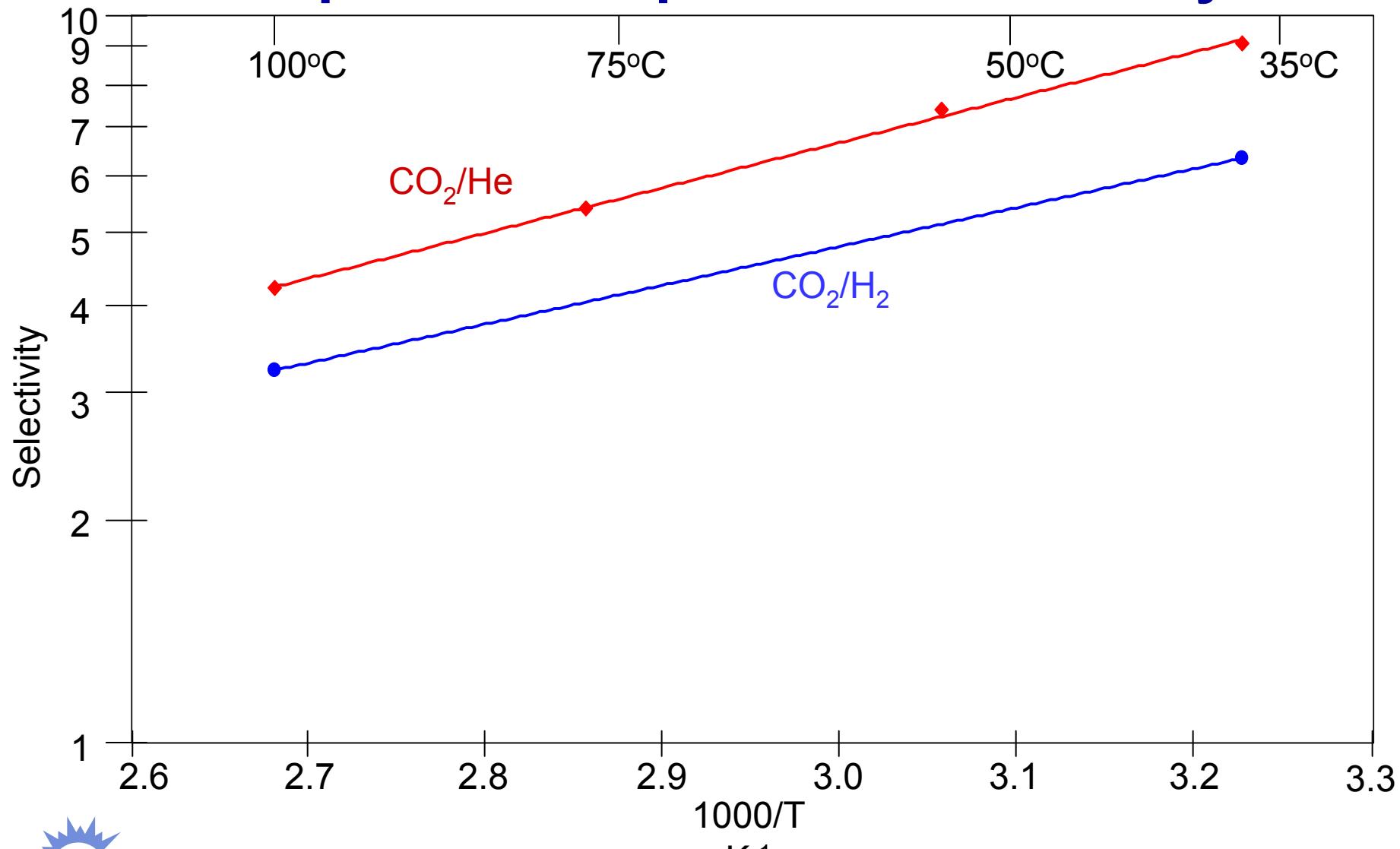
Diffusivities Comparable to Literature



Separation from H₂ Favorable



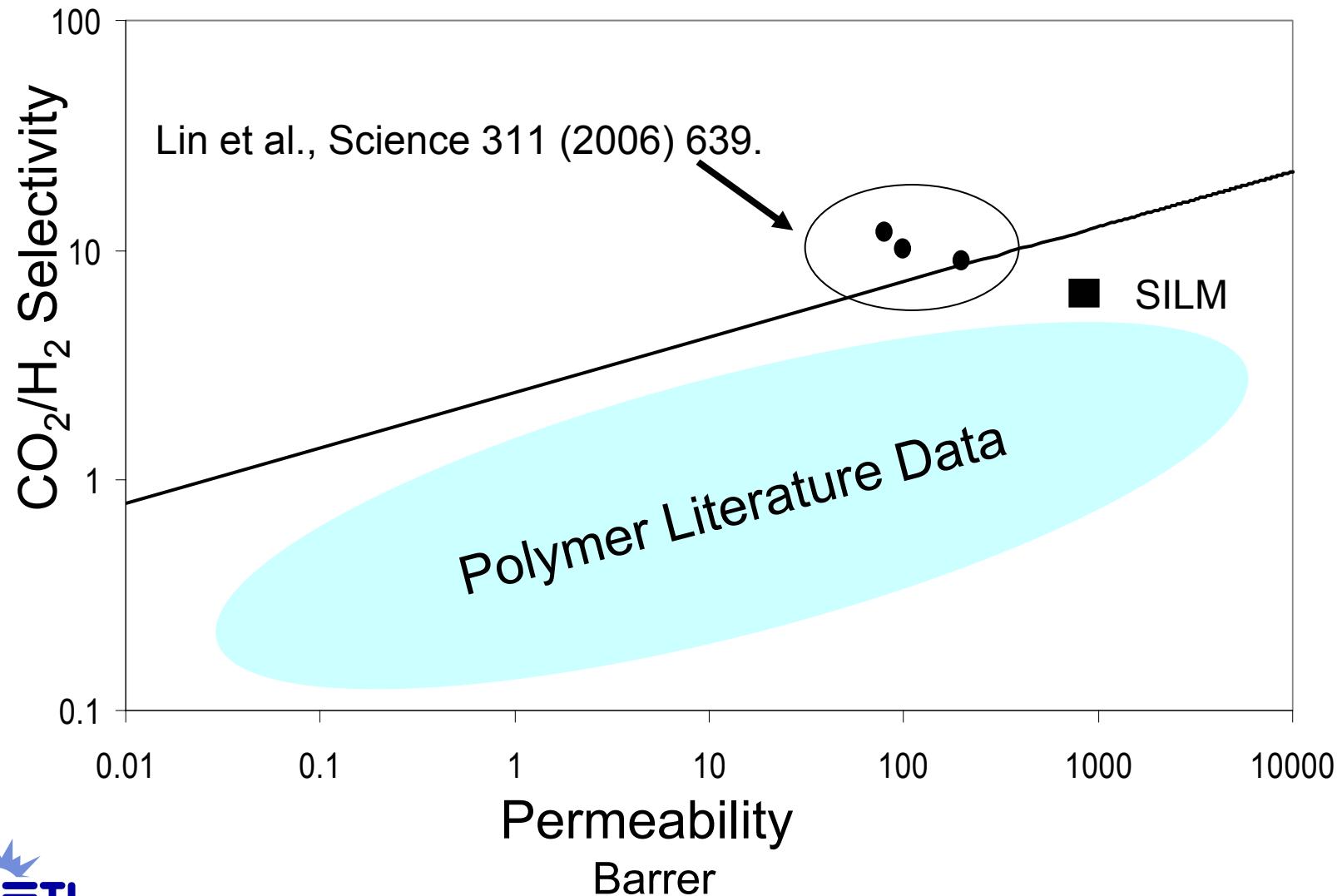
Temperature Dependence Similarity



H_2O in Feed and Non-Ideality Insignificant

	Pure Gas		Dry Gas Mixture		Wet Gas Mixture	
Temperature (°C)	37	100	37	100	37	100
CO_2 Permeability (Barrer)	817	1170	840	1040	742	1060
H_2 Permeability (Barrer)	136	359	121	350	109	367
Selectivity (CO_2/H_2)	6.4	3.3	7.0	3.0	6.8	2.9

SILM's versus Polymers



Summary

- Support selection in SILM is nontrivial.
- Support performance is predictable by DSC analysis.
- Current performance limited by support failure and IL blowout.
- Ideal and non-ideal selectivities similar.
- Performance not significantly impacted by a small amount of water in the feed.
- Unoptimized SILM's are competitive with the best polymer membranes.

Acknowledgements

The authors gratefully acknowledge the Brennecke and Maginn research groups at the University of Notre Dame. Their efforts in the synthesis and characterization of the ionic liquids along with their invaluable expertise in these areas have been very beneficial in the development of this exciting new technology. We look forward to continued fruitful collaboration.