Fifth Annual Conference on Carbon Capture & Sequestration

Capture – Membranes (1)

Nanocomposite and Ionic Materials For CO2 Capture

George Hu, Hailin Cong, Jianbin Tang, Youqing Shen
Maciej Radosz (Speaker)
Institute of Energy, Enhanced Oil Recovery Institute
Soft Materials Laboratory, Department of Chemical & Petroleum Engineering
University of Wyoming, USA

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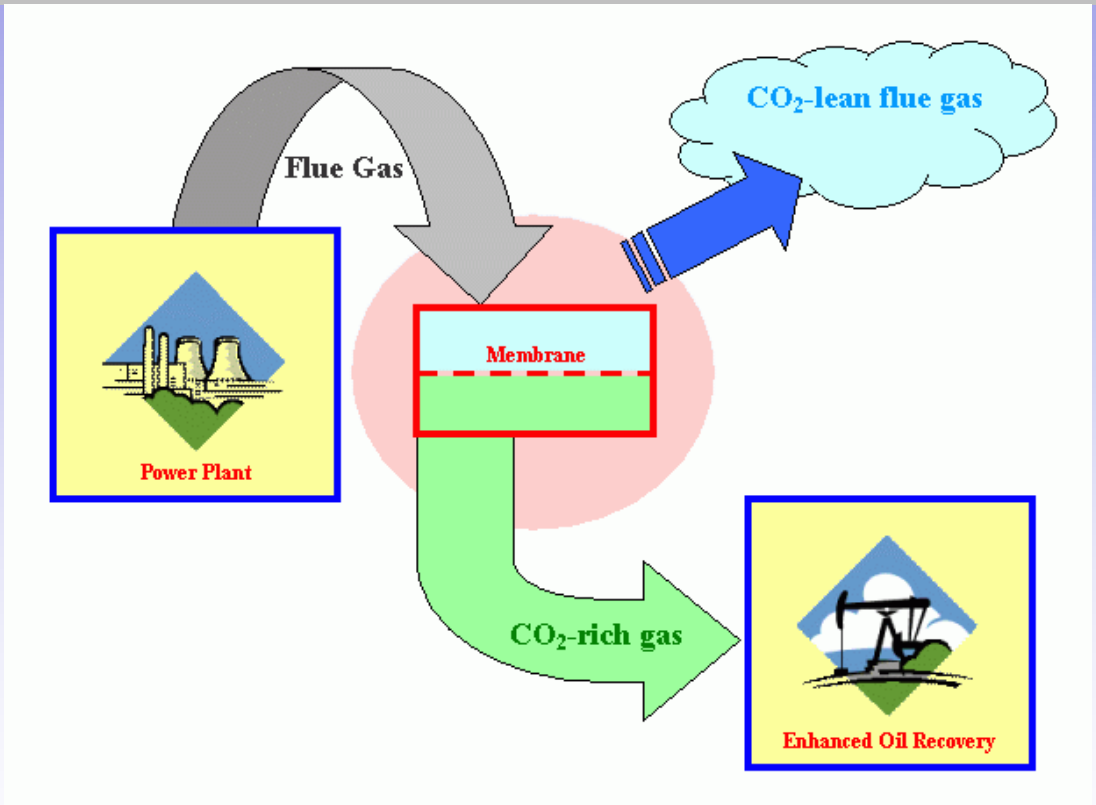
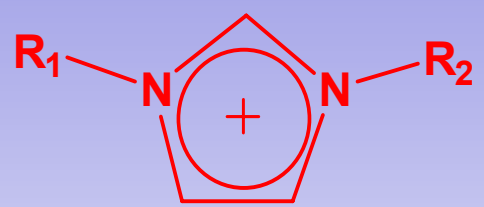
Polyionic and Nanocomposite Materials for CO_2 Recovery from Flue Gas and Natural Gas



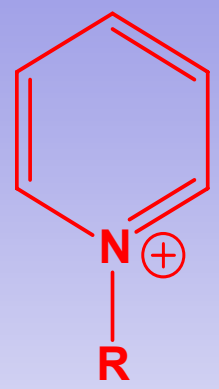
Amine absorption: $40/ton, energy intensive, corrosion, solvent loss

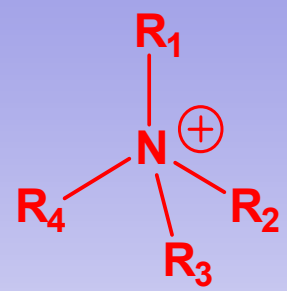
Ionic Liquids

Cations:

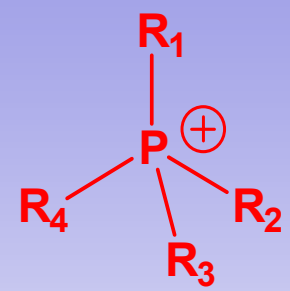


imidazolium



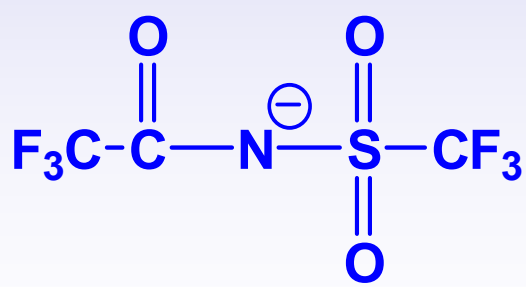


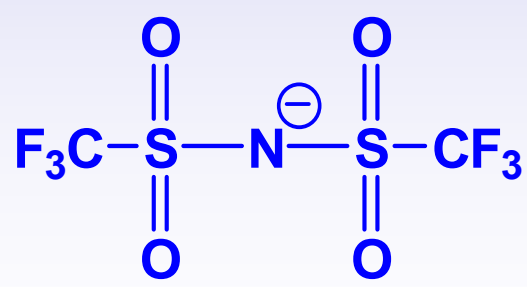
ammonium



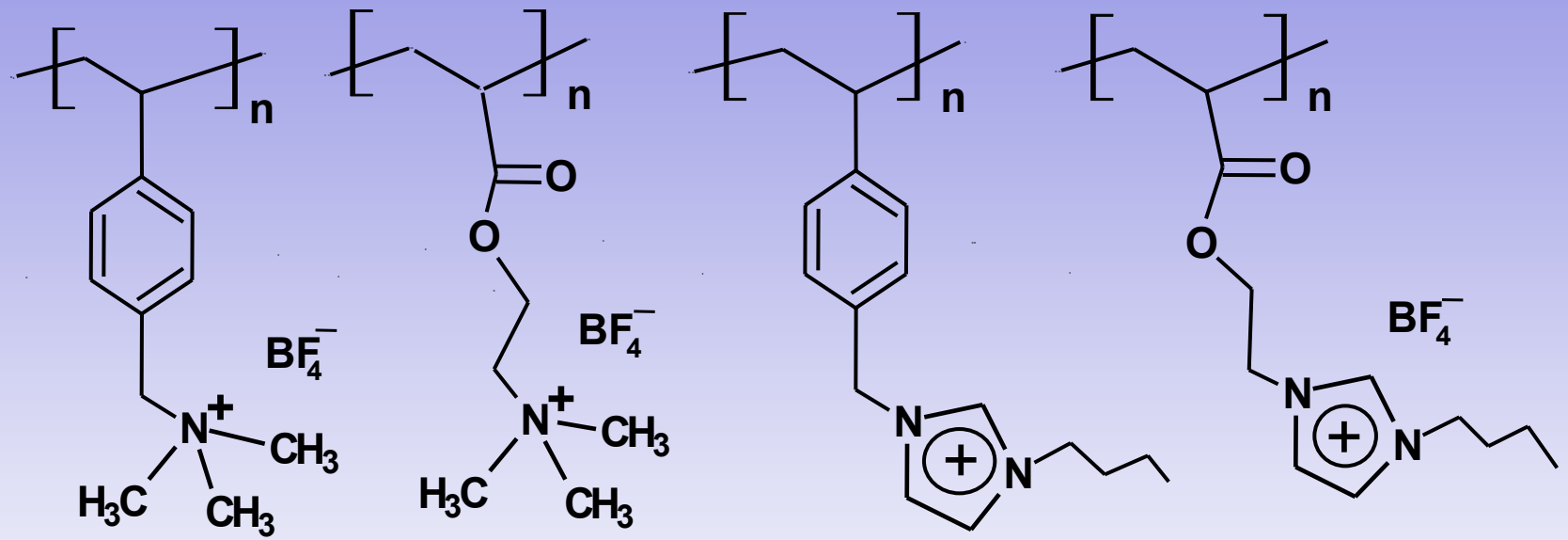
Anions:

PF_6^-, BF_4^-, $CF_3SO_3^-$





Polymers from ionic-liquid monomers

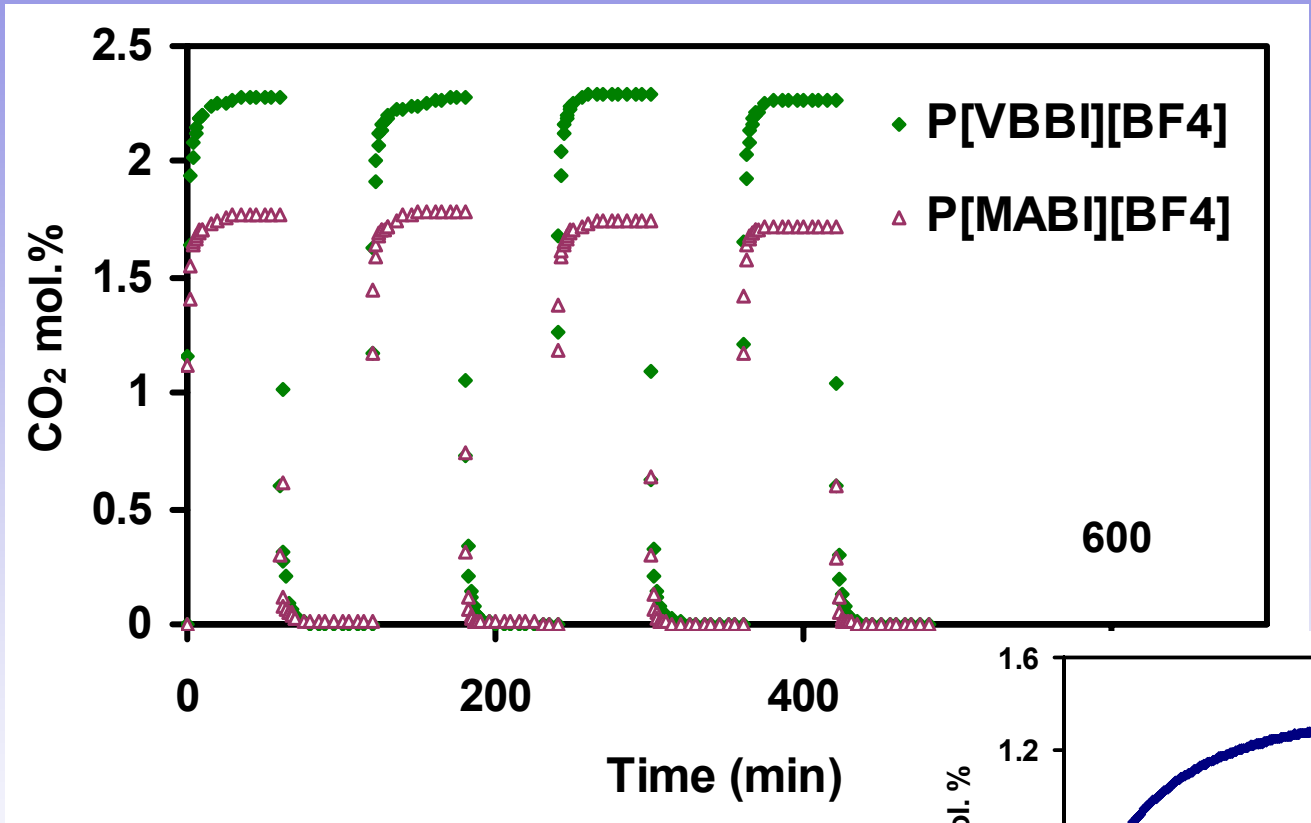


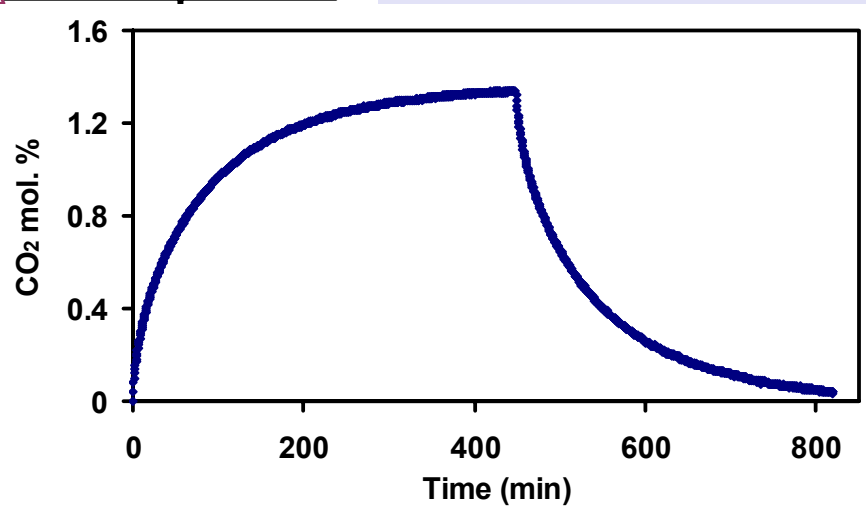
P[VBTMA][BF$_4$] P[MATMA][BF$_4$] P[VBBI][BF$_4$] P[MABI][BF

P[VBBI][Tf$_2$N]

a b e

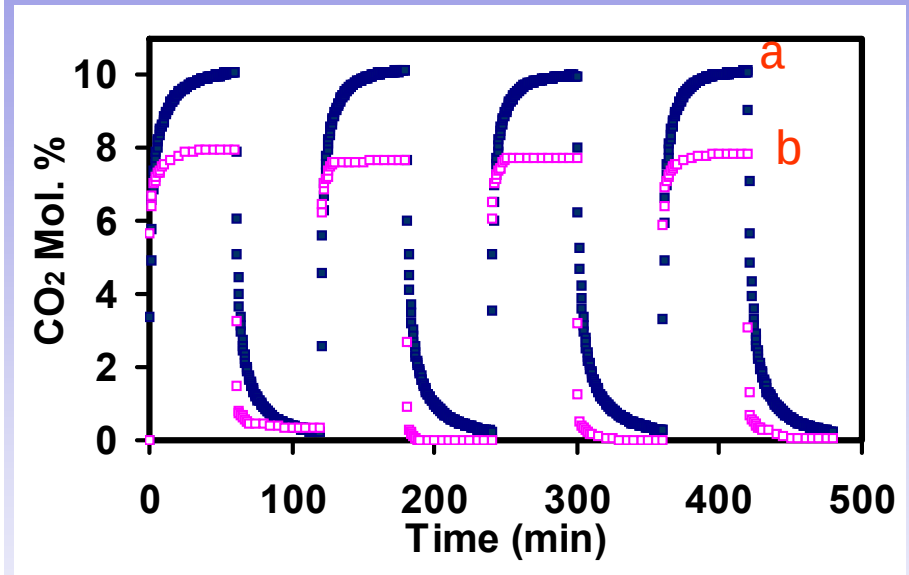
CO_2 sorption and desorption: reproducible capacities and rates

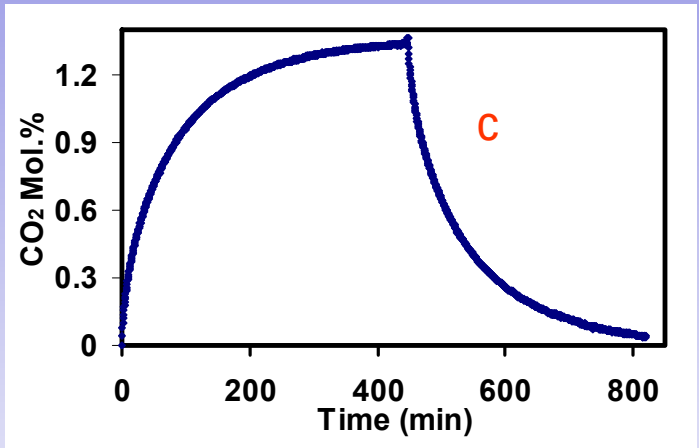


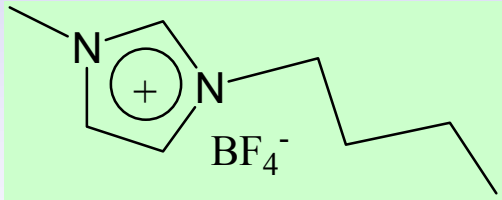


0-592.3 mmHg @22 °C
Mol % - repeat unit basis

CO_2 sorption and desorption in ammonium polyionics: rapid, reproducible, stable







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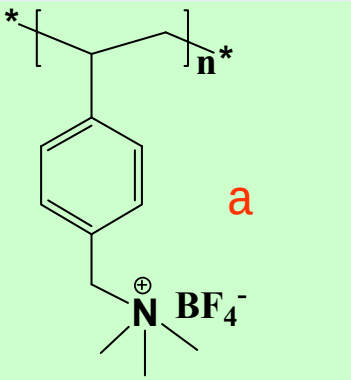
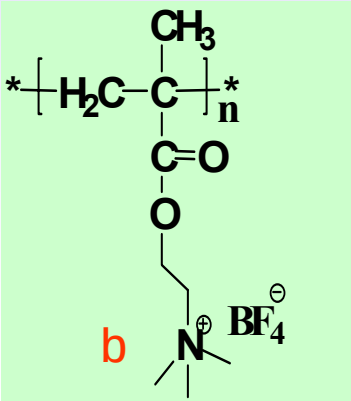


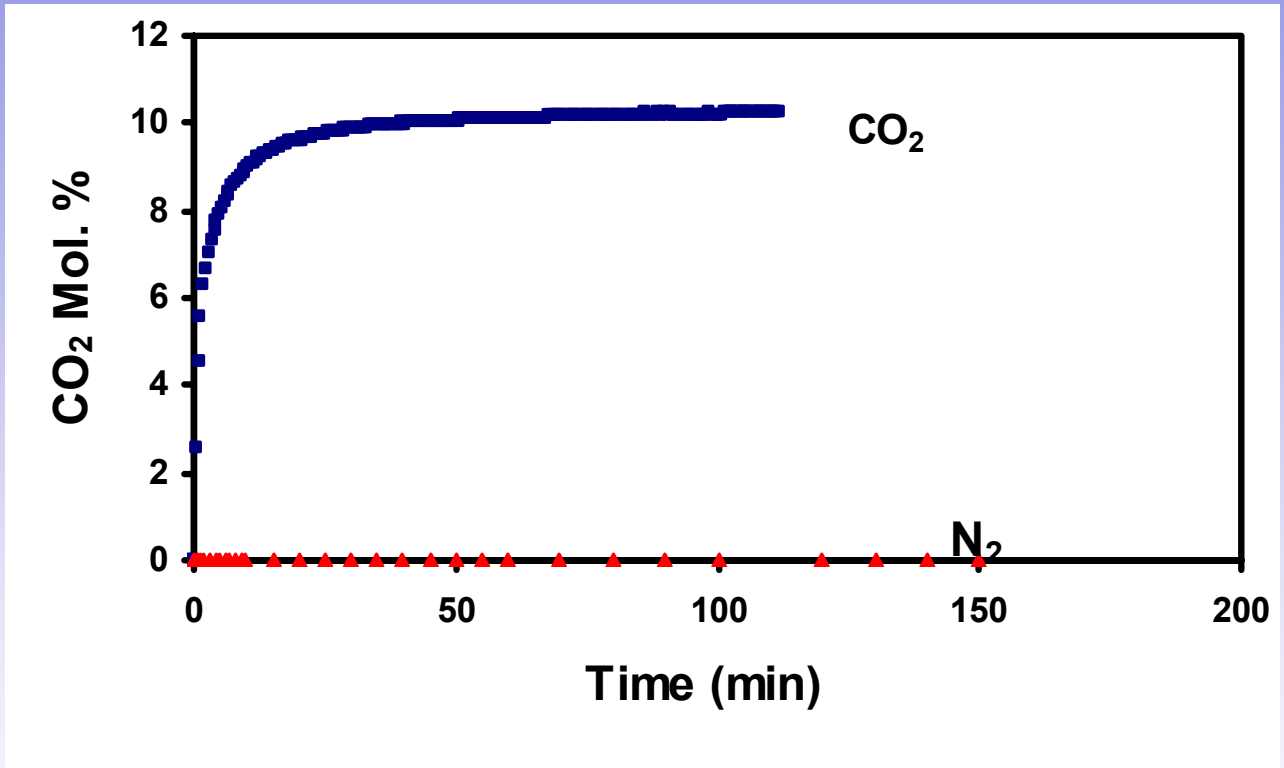
P[VBTMA][BF_4]

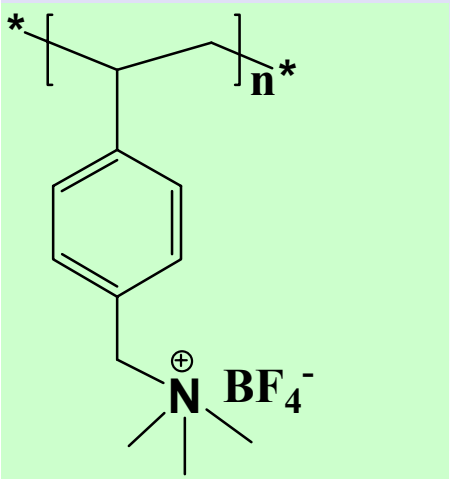


P[MATMA][BF_4]

0-592.3 mmHg @22 °C
Mol % - repeat unit basis

Polyionics: selective for CO_2



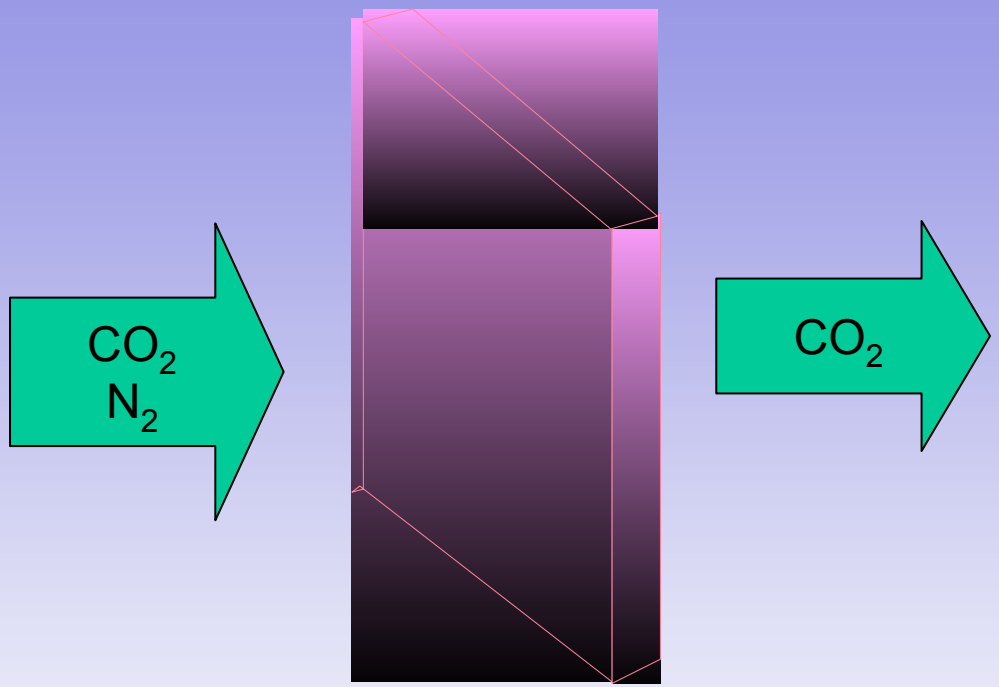


P[VBTMA][BF_4]

- Higher rates
- Higher capacities
- Different mechanism
- Film properties?

Single-film membrane

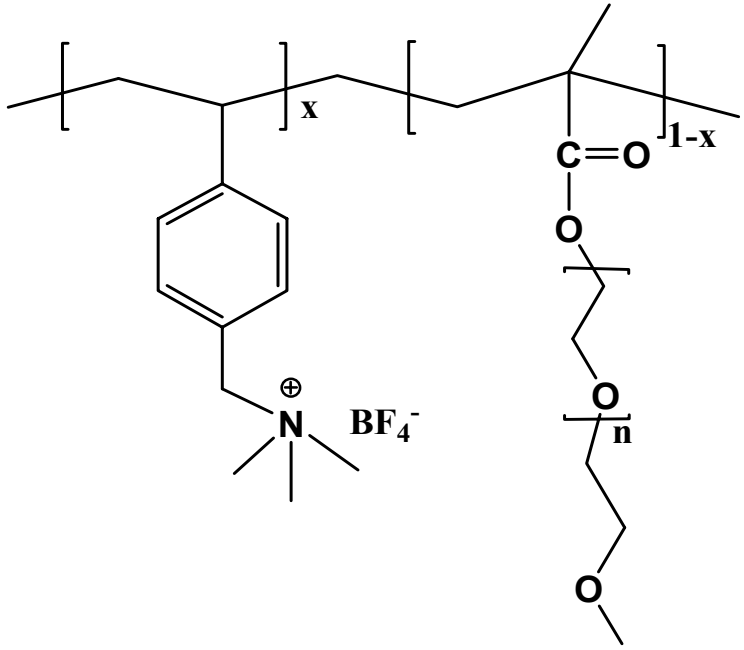
Hollow-fiber membrane



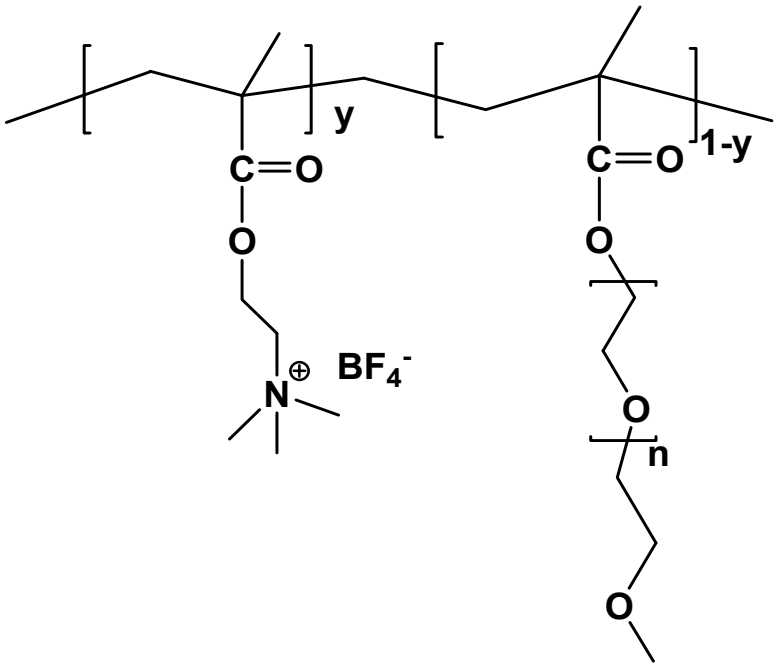
Single-film permeation cells:

1. **Rate of transport (flux, permeability)**
2. **Degree of separation (selectivity)**

Polyionic-grafted PEG for strong membranes



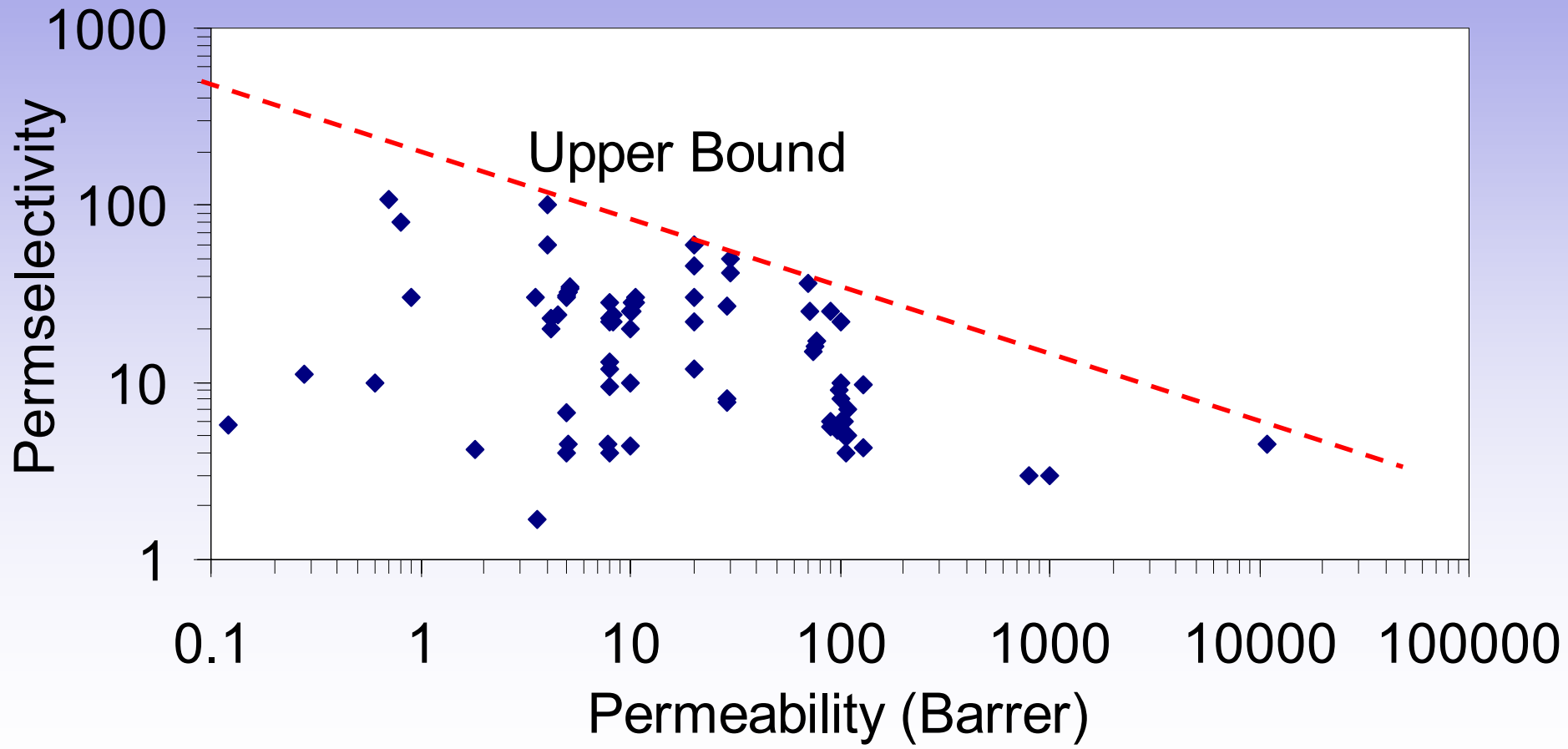
P[VBTMA][BF4]-g-PEG



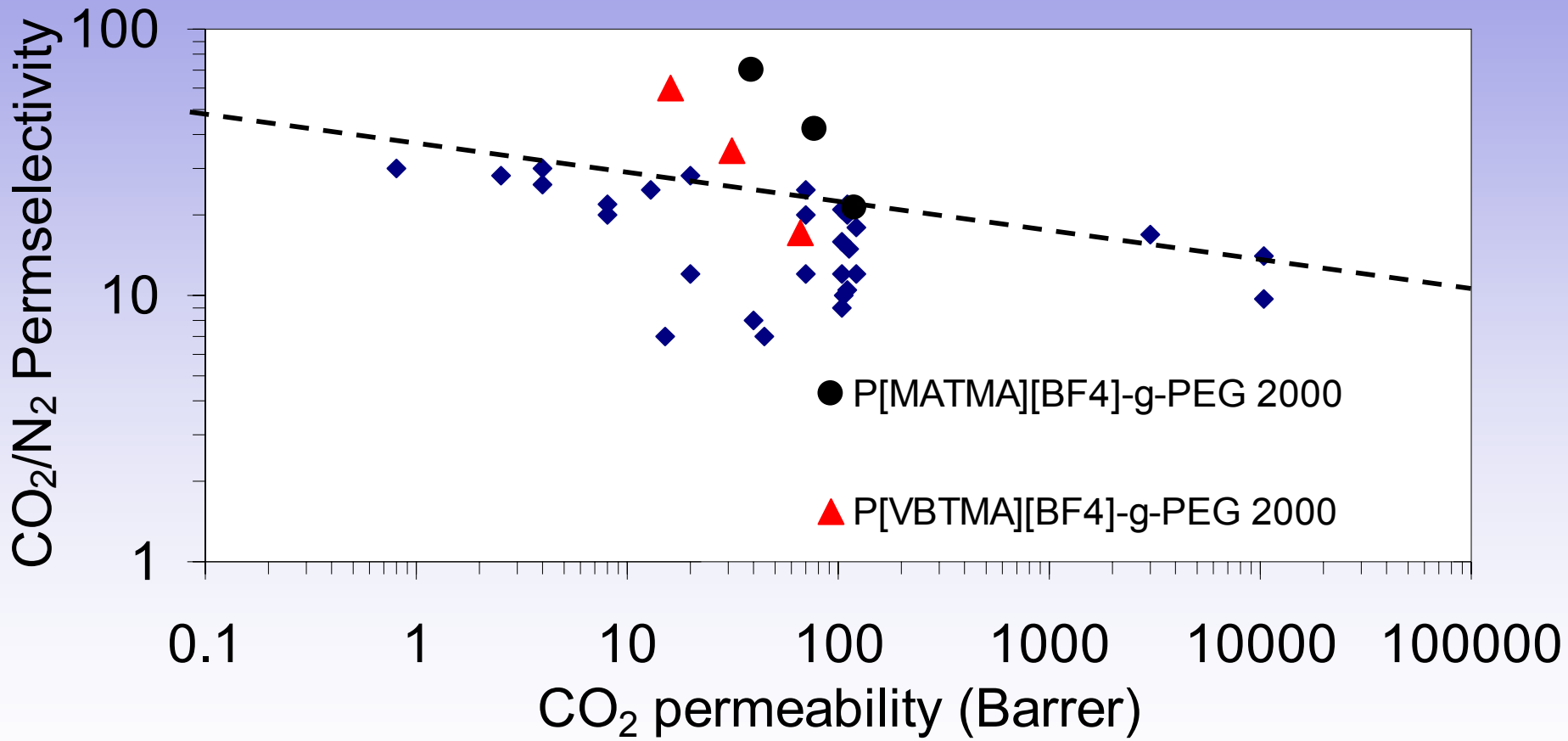
P[MATMA][BF4]-g-PEG

PEG molecular weight, copolymer composition

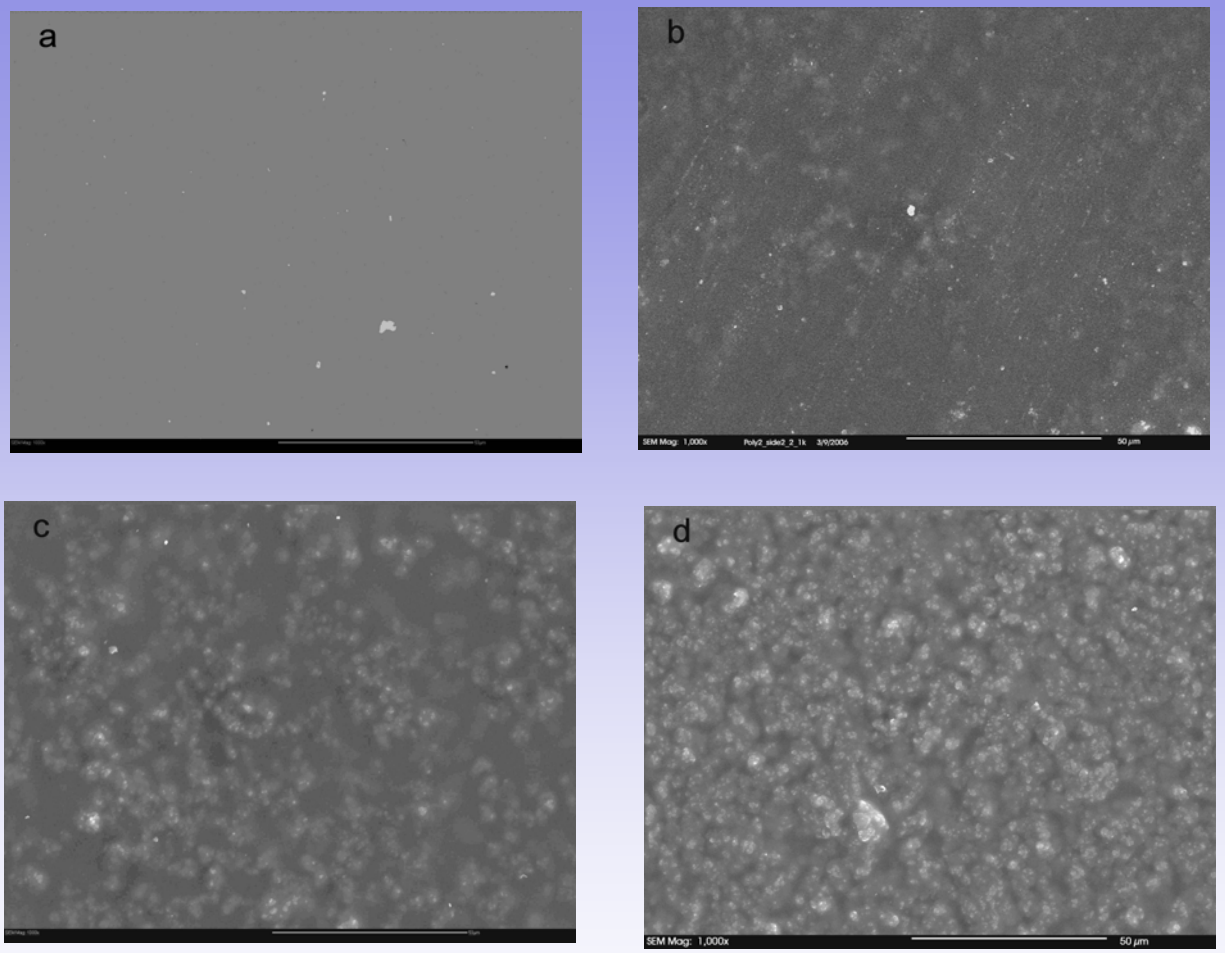
CO_2/N_2 Baseline: increase permeability, lose selectivity

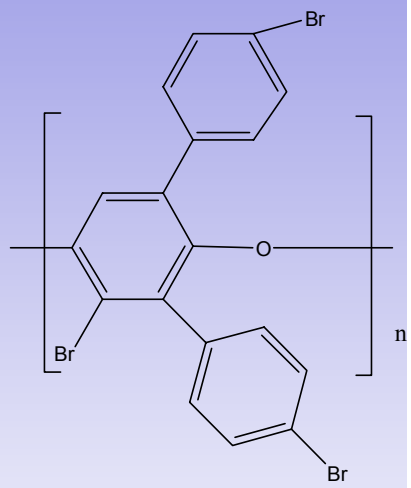


CO_2/N_2 separation



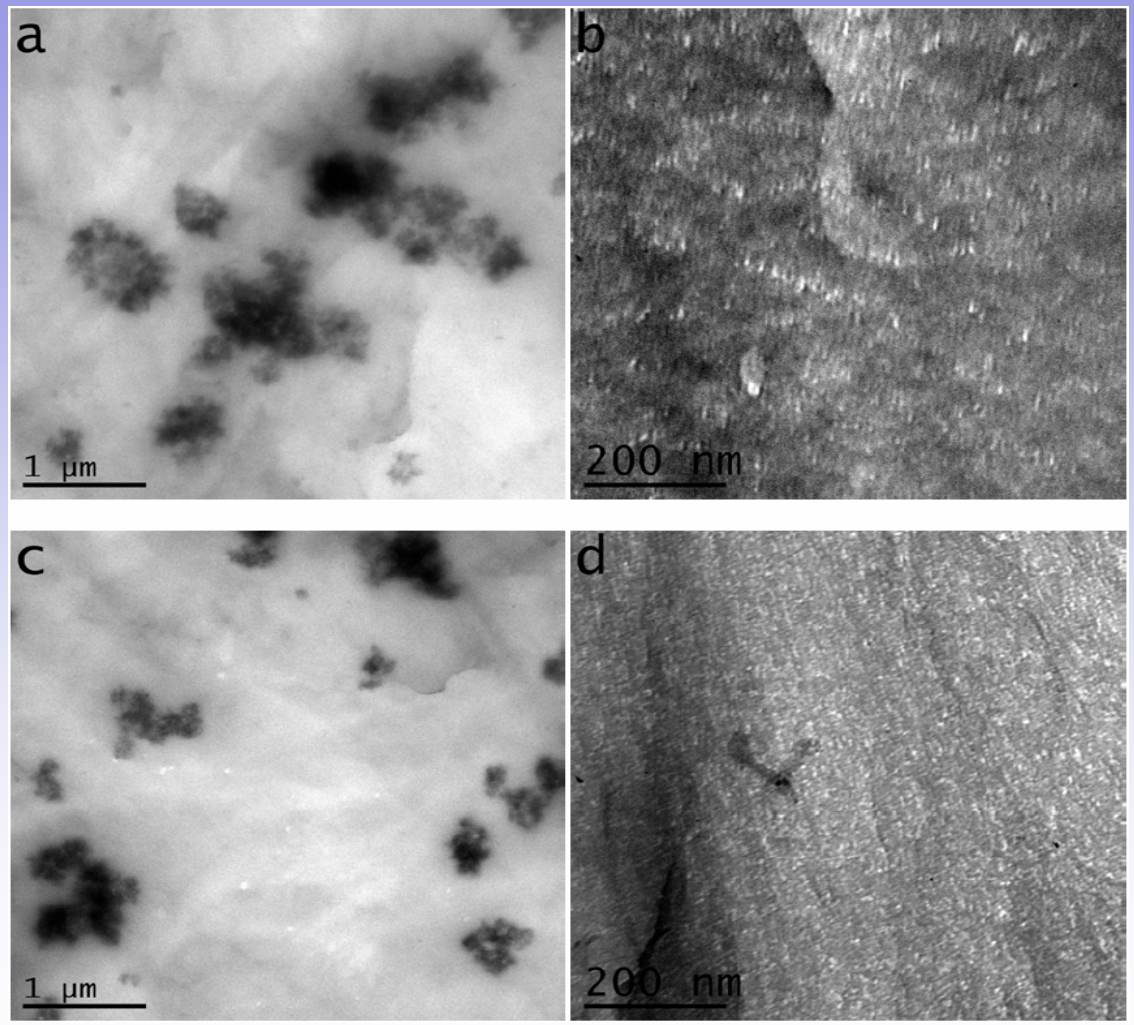
SEM morphology of silica nanocomposite membranes

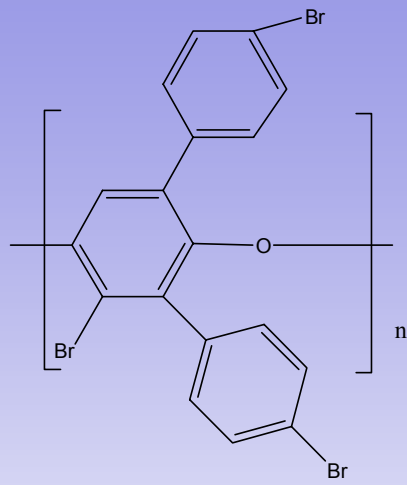


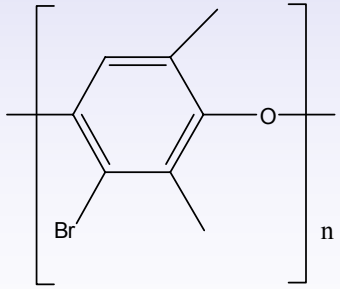


a) 0 wt % 10 nm; b) 9 wt % 10nm; c) 17 wt % 10 nm; d) 23 wt % 10 nm silica in $BPPO_{dp}$ (SEM Mag: 1000x, scale bar: 50 µm)

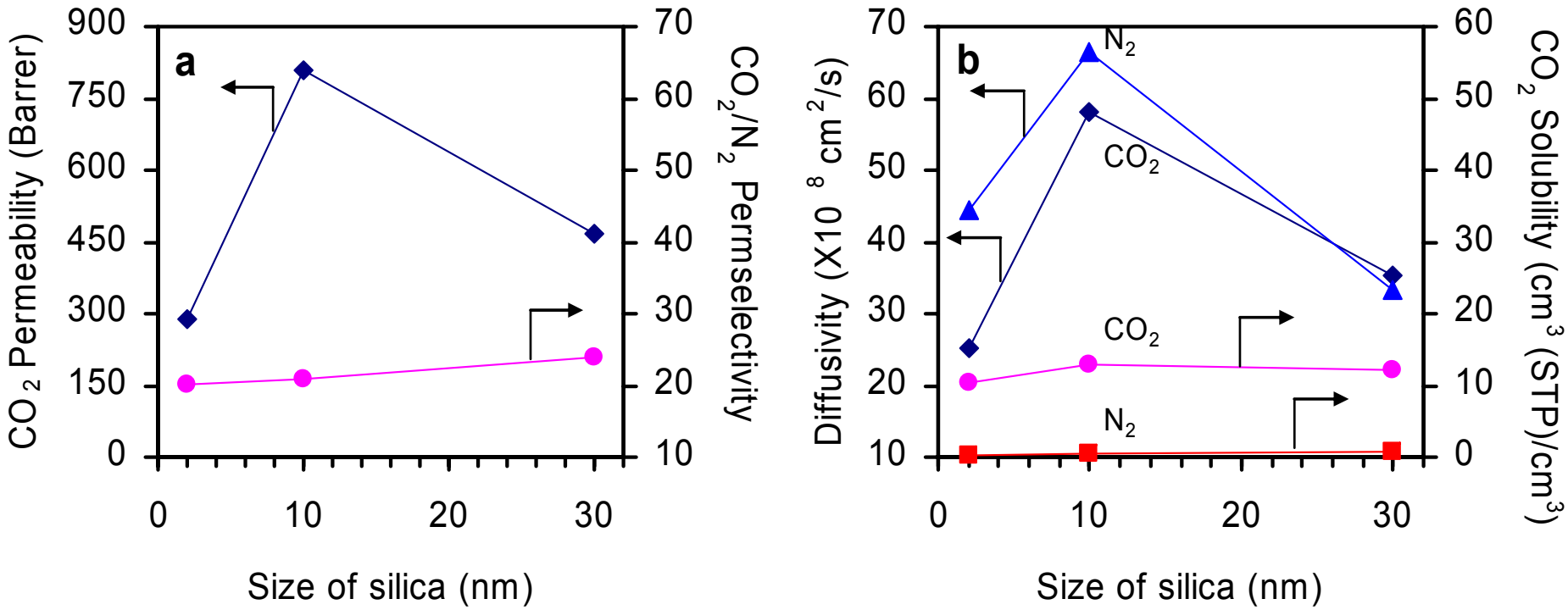
TEM morphology of 17% silica in $BPPO_{dp}$ (a,b) and $BPPO_{dm}$ (c,d)





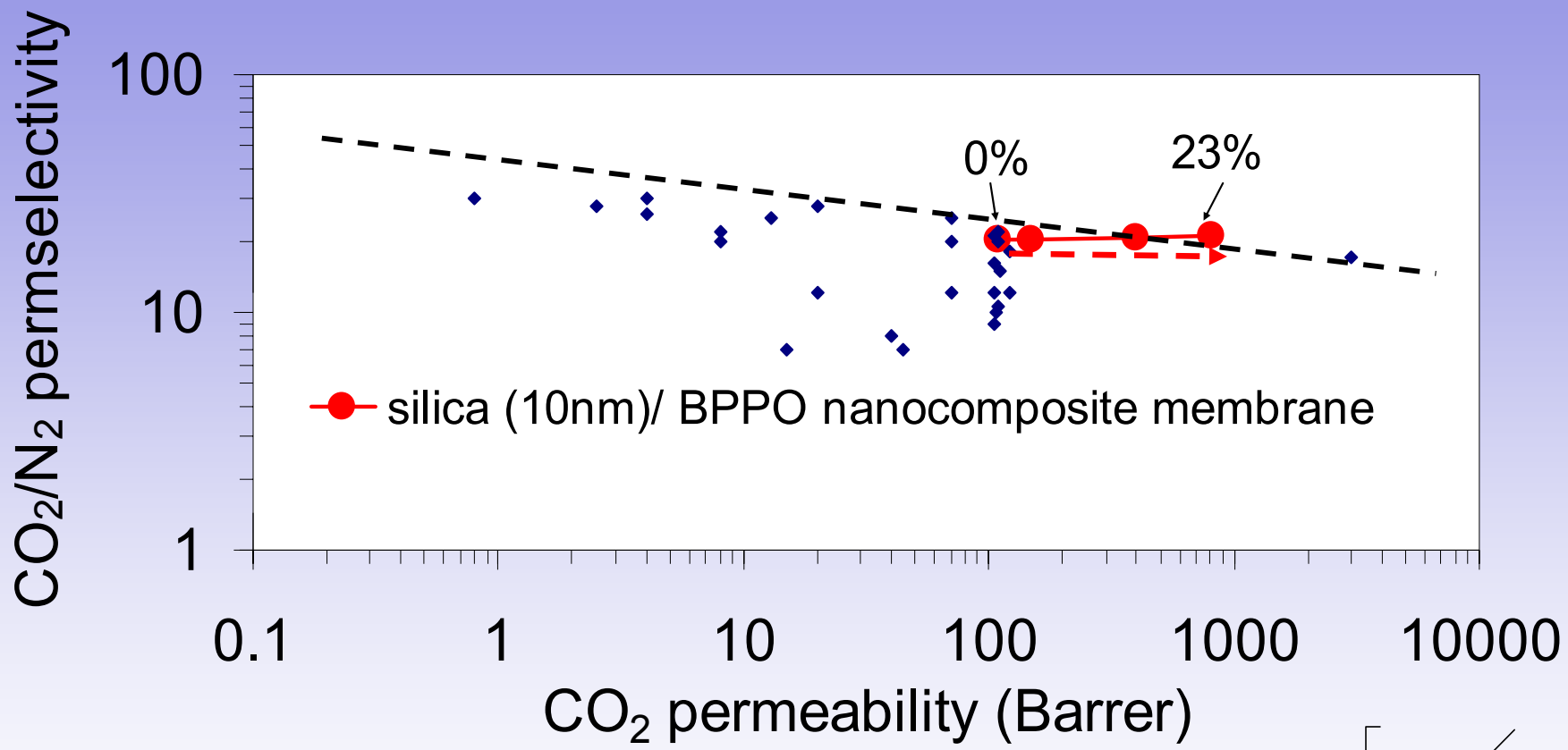


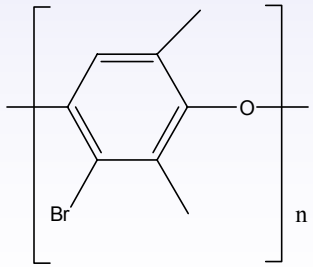
$BPPO_{dm}$+23%Silica: Best Transport for 10 nm Particles



Conditions: 10 psig feed at room temperature

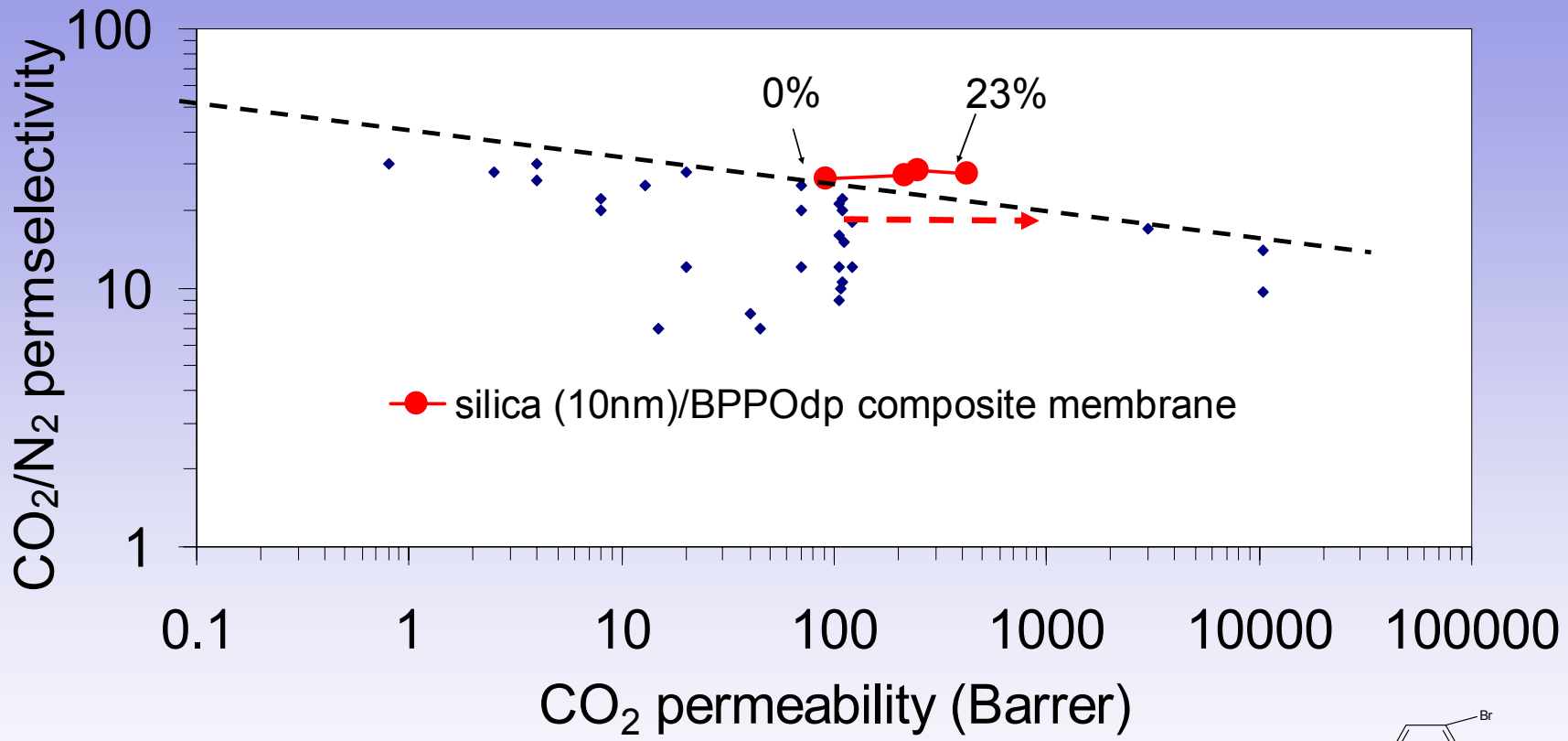
Silica-filled nanocomposite membranes



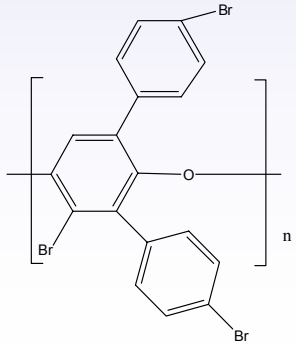


Permeability 8 times higher with silica nanoparticles

Silica-filled nanocomposite membranes



Permeability 5 times higher with silica nanoparticles



Conclusions

- Poly(ionic liquids)-g-PEG effective for CO_2/N_2 separation
- Nanosilica-BPPO membranes have better permeability, similar selectivity
- Need to explore other nanocomposites; to understand the transport and selectivity
- *…A long but fascinating journey…*