

## BENNY DEAN FREEMAN

University of Texas at Austin  
Department of Chemical Engineering  
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### EDUCATION:

- Ph.D. Chemical Engineering - January 1988  
University of California, Berkeley  
Thesis: "The Effect of Hydrostatic Pressure on Mutual Diffusion Coefficients in Polymer Solutions" Thesis Directors: Morton M. Denn and David S. Soane
- B.S. Chemical Engineering - May 1983 *Summa Cum Laude*  
North Carolina State University  
Graduate of Engineering Honors Program

### PROFESSIONAL EXPERIENCE:

#### University of Texas at Austin:

Paul D. and Betty Robertson Meek & American Petrofina Foundation Centennial Professor of Chemical Engineering, September 2007 to present.

Kenneth A. Kobe Professor of Chemical Engineering, September 2005 to present.

Matthew van Winkle Professor of Chemical Engineering, September 2002 to September 2005.

Professor of Chemical Engineering, January 2002 to present.

#### NC State University:

Professor of Chemical Engineering, November 1997 to January 2002.

Sabbatical Leave, July 2000 to December 2000. University of California, Berkeley

Associate Department Head, August 1996 to January 2002.

Associate Professor of Chemical Engineering, August 1994 to November 1997.

Assistant Professor of Chemical Engineering, August 1989 to August 1994.

**NATO Postdoctoral Fellow**, March 1988 to July 1989, Ecole Supérieure de Physique et de Chimie Industrielles de la Ville de Paris (ESPCI), Laboratoire Physico-Chimie Structurale et Macromoléculaire, 10 rue Vauquelin, 75231 Paris, France. Research directed by Professor Lucien Monnerie and Professor Liliane Bokobza.

**Graduate Student**, August 1983 to January 1988, Univ. of California, Berkeley.

**Summer Technical Hire**, E.I. duPont, Inc. Brevard, NC, Summers of 1981, 1982, and 1983.

### HONORS AND AWARDS:

ACS Award in Applied Polymer Science.....	2009
AICHE Institute Award for Excellence in Industrial Gases Technology .....	2008
IBM Faculty Award .....	2008
University CO-OP Research Excellence Award for Best Research Paper in 2006 .....	2007
ACS PMSE Cooperative Research Award .....	2002
National Academy of Engineering Frontiers of Engineering – Japan Symposium .....	2002
Strategic Environmental Research and Development Program Project of the Year.....	2001
Japan Society for the Promotion of Science Fellowship.....	1997, 2001
Alcoa Foundation Distinguished Engineering Research Award.....	2000
National Technological University Outstanding Teaching Certificate .....	2000

Academy of Outstanding Teachers .....	1997
College of Engineering Outstanding Teaching Award .....	1997
United Technologies Excellence in Teaching Award.....	1997
ALCOA Foundation Research Achievement Award.....	1996
National Academy of Engineering Frontiers of Engineering Symposium .....	1995
NSF Young Investigator Award .....	1992-1996
3M Nontenured Faculty Grant Award .....	1991-1994
NATO Postdoctoral Fellowship .....	1987
Berkeley Outstanding Graduate Instructor .....	1986
NSF Graduate Fellowship .....	1984
Berkeley Fellowship .....	1983
Phi Kappa Phi Fellowship .....	1983
P.V. Danckwerts Senior Research Prize in Chemical Engineering .....	1983
Eastern NC Section AIChE Award .....	1983
Special Service Award from NC Alpha Chapter of Tau Beta Pi .....	1983
E.I. duPont Ph.D. Fellowship .....	1982
Allied Merit Scholarship .....	1982
SOHIO Merit Scholarship .....	1981

#### **SUMMARY OF RESEARCH INTERESTS:**

Dr. Freeman's research is in polymer science and engineering and, more specifically, in mass transport in polymers. He currently directs 21 Ph.D. students and 1 postdoctoral fellow performing fundamental research in mass transport in polymers. Focus areas include structure/property correlation development for vapor separation membrane materials, new materials for hydrogen separation and natural gas purification, nanocomposite membranes, physical aging in glassy polymers, reactive barrier packaging materials, new materials with improved fouling resistance and improved permeation performance for liquid separation membranes, transport properties in nanostructured, multiphase polymers, and a variety of projects focused on the fundamentals of mass transport in polymers.

#### **RECENT EXTERNAL PROFESSIONAL ACTIVITIES:**

American Institute of Chemical Engineers: Vice-Chair (2002-2003) and Chair (2003-2004) of the Membranes Area of the Separations Division, Director of the Separations Division (2003-2008). During this time, I organized the 2003 Topical Conference on Membranes at the San Francisco meeting, which had approximately 20 sessions. I am responsible for maintenance of the Division website. I am Second Vice Chair of the Separations Division. I will serve as First Vice Chair in 2010 and Chair in 2011.

Gordon Research Conference on Membranes: Materials and Processes: Vice-Chair (2002), Chair (2004).

North American Membrane Society: Vice President (2004-2005), President (2005-2006), Member of the Board of Directors (2001-2010), Technical Program Chair of the 2004 Annual Meeting.

Chair of the International Congress on Membranes (2008), the largest membrane meeting in the world.

Polymeric Materials: Science and Engineering Division of the American Chemical Society: Vice-Chair (2003-2004), Chair (2005), Past-Chair (2006), member of the Executive Committee (1994-present), Alternate Councilor (2008-2010), served in various other capacities in this division of ACS, including Program Chair, Ford Travel Grant Chair, Member at Large, Chair of On-line Preprints Committee, and organizer of 7 symposia.

## **JOURNAL EDITORIAL ACTIVITIES:**

- Associate Editor, Industrial & Engineering Chemistry .....2007 – present  
Member, Editorial Board, The Open Macromolecules Journal .....2007 – present  
Member, Editorial Board, Journal of Membrane Science .....2005 – present  
Member, Editorial Board, Journal of Applied Membrane Science and Technology .....2005 – present  
Member, International Editorial Advisory Board, Membrane Journal .....2003 – present  
Member, International Editorial Advisory Board, Korean Membrane Journal .....2003 – present  
Member, International Editorial Advisory Board Int. Journal of Polymer Science .....2008 – present

## **BOOKS:**

1. Y.P. Yampolskii, I. Pinnau, and B.D. Freeman, *Materials Science of Membranes for Gas and Vapor Separation*, John Wiley & Sons, Ltd., New York (2006).
2. I. Pinnau and B.D. Freeman, Editors, *Advanced Materials for Membrane Separations*, ACS Symposium Series Volume 876, American Chemical Society, Washington, DC (2004).
3. I. Pinnau and B.D. Freeman, Editors, *Membrane Formation and Modification*, ACS Symposium Series Volume 744, American Chemical Society, Washington, DC (2000).
4. B.D. Freeman and I. Pinnau, Editors, *Polymeric Membranes for Gas and Vapor Separations: Chemistry and Materials Science*, ACS Symposium Series Volume 733, American Chemical Society, Washington, DC (1999).

## **PUBLICATIONS:**

1. Wang, H., J.K. Keum, A. Hiltner, E. Baer, B. Freeman, A. Rozanski, and A. Galeski, "Confined Crystallization of Polyethylene Oxide in Nanolayer Assemblies," *Science*, **323**, 757-760 (2009).
2. Greenlee, L.F., D.F. Lawler, B.D. Freeman, B. Marrot, and P. Moulin, "Reverse Osmosis Desalination: Water Sources, Technology and Today's Challenges," *Water Research, in press*.
3. Hatakeyama, E.S., H. Ju, C.J. Gabriel, J.L. Lohr, J.E. Bara, R.D. Noble, B.D. Freeman, and D.L. Gin, "New Protein-resistant Coatings for Water Filtration Membranes Based on Quaternary Ammonium and Phosphonium Polymers," *Journal of Membrane Science*, **330(1+2)**, 104-116 (2009).
4. Richards, J.J., M.K. Danquah, S. Kalakkunnath, D.S. Kalika, V.A. Kusuma, S.T. Matteucci, B.D. Freeman, "Relation Between Structure and Gas Transport Properties of Polyethylene Oxide Networks Based on Crosslinked Bisphenol A Ethoxylate Diacrylate," *Chemical Engineering Science, in press*.
5. Ferrari, M.C., S. Carranza, R.T. Bonnacaze, K.K. Tung, B.D. Freeman, and D.R. Paul, "Modeling of Oxygen Scavenging for Improved Barrier Behavior: Blend Films," *Journal of Membrane Science*, **329(1+2)**, 183-192 (2009).
6. Ju, H., B.D. McCloskey, A.C. Sagle, V.A. Kusuma, and B.D. Freeman, "Preparation and Characterization of Crosslinked Poly(ethylene glycol) Diacrylate Hydrogels as Fouling-resistant Membrane Coating Materials," *Journal of Membrane Science*, **330(1+2)**, 180-188 (2009).
7. Kusuma, V.A., B.D. Freeman, M.A. Borns, and D.S. Kalika, "Influence of Chemical Structure of Short Chain Pendant Groups on Gas Transport Properties of Cross-linked Poly(ethylene oxide) copolymers," *Journal of Membrane Science*, **271(1-2)**, pp 195–207 (2009).

8. Sagle, A.C., H. Ju, B.D. Freeman, and M.M. Sharma, "PEG-Based Hydrogel Membrane Coatings," *Polymer*, **50(3)**, pp 756–766 (2009).
9. Comer, A.C., D.S. Kalika, B.W. Rowe, B.D. Freeman, and D.R. Paul, "Dynamic Relaxation Characteristics of Matrimid<sup>®</sup> Polyimide," *Polymer*, **50(3)**, pp 891–897 (2009).
10. Ribeiro, C. and B.D. Freeman, "Sorption, Dilation, and Partial Molar Volumes of Carbon Dioxide and Ethane in Crosslinked Poly(ethylene oxide)," *Macromolecules*, **41(23)**, pp 9458–9468 (2008).
11. Li, H., D.K. Ashcraft, B.D. Freeman, M.E. Stewart, M.K. Jank, and T.R. Clark, "Non-invasive Headspace Measurement for Characterizing Oxygen-scavenging in Polymers," *Polymer*, **49(21)**, 4541-4545 (2008).
12. Hu, Y., M. Shiotsuki, F. Sanda, B.D. Freeman, and T. Masuda, "Synthesis and Properties of Indan-Based Polyacetylenes that Feature the Highest Gas Permeability Among All the Existing Polymers," *Macromolecules*, **41(22)**, 8525-8532 (2008).
13. Pethe, V. V., H.P. Wang, A. Hiltner, E. Baer, and B.D. Freeman, "Oxygen and Carbon Dioxide Permeability of EAA/PEO Blends and Microlayers," *Journal of Applied Polymer Science*, **110(3)**, 1411-1419 (2008).
14. Hill, A.J., S.J. Pas, M.R. Hill, and B.D. Freeman, "Characterising the Pore Size Distribution in Nanoporous Materials," *Polymer Preprints* (American Chemical Society, Division of Polymer Chemistry), **49(2)**, 511-512 (2008).
15. Wang, H., V. Pethe, B.D. Freeman, A. Hiltner, and E. Baer, "Polymeric Films for Selective Permeation of CO<sub>2</sub> and O<sub>2</sub>," *66<sup>th</sup> Annual Technical Conference - Society of Plastics Engineers*, 124- 128 (2008).
16. Freeman, Benny, "Journal Club," *Nature*, **454(7205)**, 671 (2008).
17. Park, H.B., B.D. Freeman, Z-B. Zhang, M. Sankir, J.E. McGrath, and B.D. Freeman, "Highly Chlorine-Tolerant Polymers for Desalination," *Angewandte Chemie*, **120(32)**, 6108-6113 (2008).
18. Kelman, S.D., R.D. Raharjo, C.W. Bielawski, and B.D. Freeman, "The Influence of Crosslinking and Fumed Silica Nanoparticles on Mixed Gas Transport Properties of Poly[1-(trimethylsilyl)-1-propyne]," *Polymer*, **49**, 3029-3041 (2008).
19. Kelman, S.D., B.W. Rowe, C.W. Bielawski, S.J. Pas, A.J. Hill, D.R. Paul, and B.D. Freeman, "Crosslinking Poly[1-(trimethylsilyl)-1-propyne] and its Effect on Physical Stability," *Journal of Membrane Science*, **320**, 123-134 (2008).
20. Kusuma, V.A., H. Lin, B.D. Freeman, M. Jose-Yacaman, S. Kalakkunnath, and D.S. Kalika, "Structure/Property Characteristics of Polar Rubbery Polymeric Membranes for Carbon Dioxide Removal from Mixtures with Light Gases," in *Membranes: Manufacturing Utilizing Six Sigma and Applications*, edited by N.N. Li, A.G. Fane, W.S.W. Ho, and T. Matsuura, Wiley, New York, pp. 929-953 (2008).
21. Paul, M., H.B. Park, B.D. Freeman, A. Roy, J.E. McGrath, and J.S. Riffle, "Synthesis and Crosslinking of Partially Disulfonated Poly(arylene ether sulfone) Random Copolymers as Candidates for Chlorine Resistant Reverse Osmosis Membranes," *Polymer*, **49(9)**, 2243-2252 (2008).

22. Wang, X.-Y., A.J. Hill, B.D. Freeman, and I.C. Sanchez, "Structural, Sorption, and Transport Characteristics of an Ultrapermeable Polymer," *Journal of Membrane Science*, **314(1-2)**, 15-23 (2008).
23. Matteucci, S., V.A. Kusuma, S.D. Kelman, and B.D. Freeman, "Gas Transport Properties of MgO Filled Poly(1-trimethylsilyl-1-propyne) Nanocomposites," *Polymer*, **49(6)**, 1659-1675 (2008).
24. Matteucci, S., R.D. Raharjo, V.A. Kusuma, S. Swinnea, and B.D. Freeman, "Gas Permeability, Solubility, and Diffusion Coefficients in 1,2-Polybutadiene Containing Magnesium Oxide," *Macromolecules*, **41(6)**, 2144-2156 (2008).
25. Matteucci, S., V.A. Kusuma, S. Swinnea, and B.D. Freeman, "Gas Permeability, Solubility and Diffusivity in 1,2-Polybutadiene Containing Brookite Nanoparticles," *Polymer*, **49(3)**, 757-773 (2008).
26. Ju, H., B.D. McCloskey, A.C. Sagle, Y.-H. Wu, V.A. Kusuma, and B.D. Freeman, "Crosslinked poly(ethylene oxide) Fouling Resistant Coating Materials for Oil/Water Separation," *Journal of Membrane Science*, **307**, 260-267 (2008).
27. Matteucci, S., V.A. Kusuma, D. Sanders, S. Swinnea, and B.D. Freeman, "Gas Transport in TiO<sub>2</sub> Nanoparticle-Filled Poly(1-trimethylsilyl-1-propyne)," *Journal of Membrane Science*, **307**, 196-217 (2008).
28. Kusuma, V.A., G. Offord, and B.D. Freeman, "Optimizing Membranes Structures for CO<sub>2</sub> Separations," *PMSE Preprints*, **98**, 283 (2008).
29. Raharjo, R.D., B.D. Freeman, D.R. Paul, and E.S. Sanders, "Pure and Mixed Gas CH<sub>4</sub> and *n*-C<sub>4</sub>H<sub>10</sub> Permeability and Diffusivity in Poly(1-trimethylsilyl-1-propyne)," *Polymer*, **48(25)**, 7329-7344 (2007).
30. Raharjo, R.D., B.D. Freeman, D.R. Paul, G.C. Sarti, E.S. Sanders, "Pure and Mixed Gas CH<sub>4</sub> and *n*-C<sub>4</sub>H<sub>10</sub> Permeability and Diffusivity in Poly(dimethylsiloxane)," *Journal of Membrane Science*, **306(1-2)**, 75-92 (2007).
31. Borns, M.A., S. Kalakkunnath, D.S. Kalika, V.A. Kusuma, and B.D. Freeman, "Dynamic Relaxation Characteristics of Cross-linked Poly(ethylene oxide) Polymer Networks: Influence of Short Chain Pendant Groups," *Polymer*, **48**, 7316-7328 (2007).
32. Kelman, S.D., S. Matteucci, C.W. Bielawski, and B.D. Freeman, "Crosslinking Poly(1-trimethylsilyl-1-propyne) and Its Effect on Solvent Resistance and Transport Properties," *Polymer*, **48**, 6881-6892 (2007).
33. Park, H.B., C.H. Jung, Y.M. Lee, A.J. Hill, S.J. Pas, S.T. Mudie, E. van Wagner, B.D. Freeman, and D.J. Cookson, "Polymers with Cavities Tuned for Fast, Selective Transport of Small Molecules and Ions," *Science*, **318**, 254-258 (2007).
34. Raharjo, R.D., B.D. Freeman, and E.S. Sanders, "Pure and Mixed Gas CH<sub>4</sub> and *n*-C<sub>4</sub>H<sub>10</sub> Sorption and Dilation in Poly(1-trimethylsilyl-1-propyne)," *Polymer*, **48(20)**, 6097-6114 (2007).
35. Kelman, S., H. Lin, E.S. Sanders, and B.D. Freeman, "CO<sub>2</sub>/C<sub>2</sub>H<sub>6</sub> Separation Using Solubility Selective Membranes," *Journal of Membrane Science*, **305(1-2)**, 57-68 (2007).

36. Park, H.B., B.D. Freeman, "Gas Separation Properties and Their Applications of Highly Permeable Amorphous Perfluoropolymer Membranes," *Memburein*, **17(2)**, 81-92 (2007).
37. Borns, M.A., S. Kalakkunnath, M.K. Danquah, V.A. Kusuma, B.D. Freeman, and D.S. Kalika, "Relaxation Properties of Poly(ethylene oxide) Copolymer Networks: Influence of Short-Chain Pendant Groups," *PMSE Preprints*, **97**, 840-841 (2007).
38. Sagle, A.C., M.M. Sharma, and B.D. Freeman, "Structure-Property Relationships in PEG-based Hydrogels for Potential Hydrophilic Membrane Coating Materials," *PMSE Preprints*, **97**, 278-279 (2007).
39. Matteucci, S., V.A. Kusuma, and B.D. Freeman, "Nanoparticle-induced Porosity in Rubbery 1,2-Polybutadiene and Its Effect on Gas Permeability," *PMSE Preprints*, **97**, 267-268 (2007).
40. Revanur, R., B. McCloskey, K. Breitenkamp, B.D. Freeman, and T. Emrick, "Reactive Amphiphilic Graft Copolymer Coatings Applied to Poly(vinylidene fluoride) Ultrafiltration Membranes," *Macromolecules*, **40(10)**, 3624-3630 (2007).
41. Matteucci, S., E. Van Wagner, B.D. Freeman, S. Swinnea, T. Sakaguchi, and T. Masuda, "Desilylation of Substituted Polyacetylenes by Nanoparticles," *Macromolecules*, **40(9)**, 3337-3347 (2007).
42. Rowe, B.W., B.D. Freeman, and D.R. Paul, "Effect of Sorbed Water and Temperature on the Optical Properties and Density of Thin Glassy Polymer Films on a Silicon Substrate," *Macromolecules*, **40(8)**, 2806-2813 (2007).
43. Kalakkunnath, S., D.S. Kalika, H. Lin, R.D. Raharjo, and B.D. Freeman, "Molecular Dynamics of Poly(ethylene glycol) and Poly(propylene glycol) Copolymer Networks by Broadband Dielectric Spectroscopy," *Macromolecules*, **40(8)**, 2773-2781 (2007).
44. Raharjo, R.D., B.D. Freeman, and E.S. Sanders, "Pure and Mixed Gas CH<sub>4</sub> and n-C<sub>4</sub>H<sub>10</sub> Sorption and Dilation in Poly(dimethylsiloxane)," *Journal of Membrane Science*, **292**, 45-61 (2007).
45. Paul, M., A. Roy, H.B. Park, B.D. Freeman, J. Riffle, and J.E. McGrath, "Synthesis and Crosslinking of Poly(arylene ether sulfone) Blend Membranes," *Polymer Preprints* (American Chemical Society, Division of Polymer Chemistry) **48(1)**, 334-335 (2007).
46. Kono, T., Y. Hu, T. Masuda, K. Tanaka, R.D. Priestley, and B.D. Freeman, "Effect of Fumed Silica Nanoparticles on the Gas Permeation Properties of Substituted Polyacetylene Membranes," *Polymer Bulletin*, **58(5-6)**, 995-1003 (2007).
47. Lin, H., B.D. Freeman, S. Kalakkunnath, and D.S. Kalika, "Effect of Copolymer Composition, Temperature, and Carbon Dioxide Fugacity on Pure- and Mixed-Gas Permeability in Poly(ethylene glycol)-Based Materials: Free Volume Interpretation," *Journal of Membrane Science*, **291**, 131-139 (2007).
48. Worrel, L.S., J.A. Morehouse, L.A. Shimko, D.R. Lloyd, D.F. Lawler, and B.D. Freeman, "Enhancement of track-etched membrane performance via stretching," *Separation and Purification Technology*, **53(1)**, 71-80 (2007).

49. Kalakkunnath, S., D.S. Kalika, H. Lin, R.D. Raharjo and B.D. Freeman, "Molecular Relaxation in Crosslinked Poly(ethylene glycol) and Poly(propylene glycol) Diacrylate Networks by Dielectric Spectroscopy," *Polymer*, **48**, 579-589 (2007).
50. Dworak, D.P., H. Lin, B.D. Freeman, and M.D. Soucek, "Gas Permeability Analysis of Photo-cured Cyclohexyl-substituted Polysiloxane films," *Journal of Applied Polymer Science*, **102(3)**, 2343-2351 (2006).
51. Park, N.B., C.H. Lee, J.Y. Sohn, Y.M. Lee, B.D. Freeman, and H.J. Kim, "Effect of Crosslinked Chain Length in Sulfonated Polyimide Membranes on Water Sorption, Proton Conduction, and Methanol Permeation Properties," *Journal of Membrane Science*, **285(1-2)**, 432-443 (2006).
52. Lin, H., and B.D. Freeman, "Permeation and Diffusion," in *Handbook of Materials Measurement Methods*, Edited by H. Czichos, T. Saito, and L.E. Smith, Springer, New York, pp. 371-387 (2006).
53. Wang, X.-Y., F.T. Willmore, R.D. Raharjo, X. Wang, B.D. Freeman, A.J. Hill, and I.C. Sanchez, "Molecular Simulations of Physical Aging in Polymer Membrane Materials," *Journal of Physical Chemistry B*, **110(33)**, 16685-16693 (2006).
54. Morehouse, J.A., D.R. Lloyd, B.D. Freeman, D.F. Lawler, K.M. Liechti, and E.B. Becker, "Modeling the Stretching of Microporous Membranes," *Journal of Membrane Science*, **283(1+2)**, 430-439 (2006).
55. Raharjo, R.D., H. Lin, D.F. Sanders, B.D. Freeman, S. Kalakkunnath and D.S. Kalika, "Relation Between Network Structure and Gas Transport in Crosslinked poly (propylene glycol diacrylate)," *Journal of Membrane Science*, **283**, 253-265 (2006).
56. Morehouse, J.A., D.L. Taylor, D.R. Lloyd, D.F. Lawler, B.D. Freeman, and L.S. Worrel, "The Effect of Uni-axial Stretching on the Roughness of Microfiltration Membranes," *Journal of Membrane Science*, **280(1-2)**, 712-719 (2006).
57. Jansen, J.C., M. Macchione, R. Raharjo, B.D. Freeman, and E. Drioli, "Pure and Mixed Gas Transport Properties of Novel Asymmetric Poly(ether ether ketone) Membranes with Different Morphologies," *Desalination*, **199(1-3)**, 461-463 (2006).
58. Wang, X.-Y., R.D. Rajarjo, H.J. Lee, Y. Lu, B.D. Freeman, and I.C. Sanchez, "Molecular Simulation and Experimental Study of Substituted Polyacetylenes: Fractional Free Volume, Cavity Size Distribution and Diffusion Coefficients," *Journal of Physical Chemistry B*, **110**, 12666-12672 (2006).
59. Kalakkunnath, S., D.S. Kalika, H. Lin, and B.D. Freeman, "Viscoelastic Characteristics of UV Polymerized Poly(ethylene glycol) Diacrylate Networks with Varying Extents of Crosslinking," *Journal of Polymer Science: Part B, Polymer Physics*, **44**, 2058-2070 (2006).
60. Matteucci, S., Yu. Yampolskii, B.D. Freeman, I. Pinnau, "Transport of Gases and Vapors in Glassy and Rubbery Polymers," in *Materials Science of Membranes for Gas and Vapor Separation*, Edited by Y.P. Yampolskii, I. Pinnau, and B.D. Freeman, John Wiley & Sons, Ltd., New York, pp. 1-47 (2006).
61. Merkel, T.C., I. Pinnau, R. Prabhakar, and B.D. Freeman, "Gas and Vapor Transport Properties of Perfluoropolymers," in *Materials Science of Membranes for Gas and Vapor Separation*, Edited

- by Y.P. Yampolskii, I. Pinnau, and B.D. Freeman, John Wiley & Sons, Ltd., New York, pp. 251-270 (2006).
62. Lin, H., E. van Wagner, B.D. Freeman, L.G. Toy, and R.P. Gupta, "Plasticization-Enhanced H<sub>2</sub> Purification Using Polymeric Membranes," *Science*, **311(5761)**, 639-642 (2006).
  63. Lin, H., E. van Wagner, J.S. Swinnea, B.D. Freeman, S.J. Pas, A.J. Hill, S. Kalakkunnath, and D.S. Kalika, "Transport and Structural Characteristics of Crosslinked Poly(ethylene oxide) Rubbers," *Journal of Membrane Science*, **276(1-2)**, 145-161 (2006).
  64. Freeman, B.D., "Gas Separations Perspectives," *Maku*, **31(2)**, 86-90 (2006).
  65. Lin, H. and B.D. Freeman, "Gas Permeation and Diffusion in Cross-Linked Poly(ethylene glycol diacrylate)," *Macromolecules*, **39(10)**, 3568-3580 (2006).
  66. Morehouse, J. A., L.S. Worrel, D.L. Taylor, D.R. Lloyd, B.D. Freeman, and D.F. Lawler, "The Effect of Uni-axial Orientation on Macroporous Membrane Structure," *Journal of Porous Materials*, **13(1)**, 61-72 (2006).
  67. Zeng, X., C. Braman, D.L. Gin, B.D. Freeman, "Novel Functional Membrane Coating for Protein Anti-fouling: Design, Synthesis, and Characterization," *PMSE Preprints*, **94**, 543 (2006).
  68. Lee, C.H., H.B. Park, Y.S. Chung, Y.M. Lee, and B.D. Freeman, "Water Sorption, Proton Conduction, and Methanol Permeation Properties of Sulfonated Polyimide Membranes Cross-Linked with N,N-Bis(2-hydroxyethyl)-2-aminoethanesulfonic Acid (BES)," *Macromolecules*, **39(2)**, 755-764 (2006).
  69. Shida, Y., T. Sakaguchi, M. Shiotsuki, F. Sanda, B.D. Freeman, T. Masuda, "Synthesis and Properties of Membranes of Poly(diphenylacetylenes) Having Fluorines and Hydroxyl Groups," *Macromolecules*, **39(2)**, 569-574 (2006).
  70. Lin, H., E. van Wagner, B.D. Freeman, and I. Roman, "High Performance Polymer Membranes for Natural Gas Sweetening," *Advanced Materials*, **18**, 39-44 (2006).
  71. De Angelis, M. G., F. Doghieri, G.C. Sarti, B.D. Freeman, "Modeling Gas Sorption in Amorphous Teflon Through the Non Equilibrium Thermodynamics for Glassy Polymers (NET-GP) Approach," *Desalination*, **193(1-3)**, 82-89 (2006).
  72. Ju, H., B. McCloskey, A. Sagle, Y-H. Wu, E. Van Wagner, H.B. Park, B.D. Freeman, L. Shimko, D.F. Lawler, and M.M. Sharma, "Synthesis and Characterization of Surface Coated Ultrafiltration Membranes to Enhance Oil/Water Fouling Resistance," *PMSE Preprints*, **95**, 973-974 (2006).
  73. Revanur, R., B. McCloskey, K. Breitenkamp, B.D. Freeman, and T. Emrick, "Amphiphilic Graft Copolymers as Anti-Fouling Coatings for Water Purification Membranes," *PMSE Preprints*, **95**, 972 (2006).
  74. Park, H.B., B.D. Freeman, Z.-B. Zhang, G.-Y. Fan, M. Sankir, and J.E. McGrath, "Water and Salt Transport Behavior Through Hydrophilic-Hydrophobic Copolymer Membranes and Their Relations to Reverse Osmosis Membrane Performance," *PMSE Preprints*, **95**, 889-891 (2006).

75. Zhang, Z.-B., G.-Y. Fan, M. Sankir, H.B. Park, B.D. Freeman, and J.E. McGrath, "Synthesis of Di-sulfonated Poly(arylene ether sulfone) Random Copolymers as Novel Candidates for Chlorine-Resistant Reverse Osmosis Membranes," *PMSE Preprints*, **95**, 887-888 (2006).
76. Kelman, S.D., B.D. Freeman, C.W. Bielawski, and A.J. Hill, "Enhancing the Chemical Resistance of High Fractional Free Volume Vapor-Selective Polymers," *PMSE Preprints*, **95**, 810-811 (2006).
77. Wang, X.-Y., B.D. Freeman, I.C. Sanchez, and A.J. Hill, "Effect of Free Volume on Gas Sorption in Polymeric Membranes" *PMSE Preprints*, **95**, 809 (2006).
78. Jung, C.H., H.B. Park, A.J. Hill, B.D. Freeman, Y.M. Lee, "High Performance Polymer Membrane Rendered by Thermal Conversion Process," *PMSE Preprints*, **95**, 617-618 (2006).
79. Raharjo, R.D., B.D. Freeman, E.S. Sanders, "Fundamental Study of Mixture Permeability, Solubility, and Diffusivity in Vapor Selective Polymers," *PMSE Preprints*, **95**, 331-332 (2006).
80. Wang, X.-Y., K.M. Lee, Y. Lu, M.T. Stone, I.C. Sanchez, and B.D. Freeman, "Modeling Transport Properties in High Free Volume Glassy Polymers," in *New Polymer Materials (ACS Symposium Series #916)*, Edited by L.S. Korugic-Karasz, W.J. MacKnight, and E. Martuscelli, American Chemical Society, pp. 187-200, Washington, DC (2005).
81. Sakaguchi, T., M. Shiotsuki, F. Sanda, B.D. Freeman, and T. Masuda, "Synthesis and Properties of F-Containing Poly(diphenylacetylene) Membranes," *Macromolecules*, **38**, 8327-8332 (2005).
82. Wang, X.-Y., P.J. in't Veld, Y. Lu, B.D. Freeman, and I.C. Sanchez, "A Molecular Simulation Study of Cavity Size Distributions and Diffusion in *para* and *meta* Isomers," *Polymer*, **46**, 9155-9161 (2005).
83. Kalakkunnath, S., D.S. Kalika, H. Lin, and B.D. Freeman, "Segmental Relaxation Characteristics of Crosslinked Poly(ethylene oxide) Copolymer Networks," *Macromolecules*, **38**, 9679-9687 (2005).
84. Kalakkunnath, S., H. Lin, B.D. Freeman, and D.S. Kalika, "Relaxation Characteristics of Crosslinked Poly(ethylene glycol) Diacrylates and Their Relation to Gas Transport Properties," *PMSE Preprints*, **93**, 332-333 (2005).
85. Sagle, A.C., D.L. Gin, M. Sharma, and B.D. Freeman, "Chlorine Resistance Studies on Membranes," *PMSE Preprints*, **93**, 732-733 (2005).
86. Lin, H., T. Kai, B.D. Freeman, S. Kalakkunnath, and D.S. Kalika, "The Effect of Crosslinking on Gas Permeability in Crosslinked Poly(ethylene glycol diacrylate)," *Macromolecules*, **38**, 8381-8393 (2005).
87. Lin, H. and B.D. Freeman, "Gas and Vapor Solubility in Crosslinked Poly(ethylene glycol diacrylate)," *Macromolecules*, **38**, 8394-8407 (2005).
88. Raharjo, R.D., H.J. Lee, B.D. Freeman, T. Sakaguchi, and T. Masuda, "Pure Gas and Vapor Permeation Properties of Poly[1-phenyl-2-[*p*-(trimethylsilyl)phenyl]acetylene] (PTMSDPA) and its desilylated analog, poly[diphenylacetylene] (PDPA)," *Polymer*, **46(17)**, 6316-6324 (2005).

89. Prabhakar, R.S., De Angelis, M.G., Sarti, G.C., Freeman, B.D., and M.C. Coughlin, "Gas and Vapor Sorption, Permeation and Diffusion in Poly(tetrafluoroethylene-co-perfluoromethyl vinyl ether)," *Macromolecules*, **38(16)**, 7043-7055 (2005).
90. Zhong, J., Lin, G., Wen, W.-Y., Jones, A.A., Kelman, S., Freeman, B.D., "Translation and Rotation of Penetrants in Ultrapermeable Nanocomposite Membrane of Poly(2,2-bis(trifluoromethyl)-4,5-difluoro-1,3-dioxole-co-tetrafluoroethylene) and Fumed Silica," *Macromolecules*, **38(9)**, 3754-3764 (2005).
91. Shida, Y., Sakaguchi, T., Shiotsuki, M., Sanda, F., Freeman, B.D., and T. Masuda, "Synthesis and Properties of Poly(diphenylacetylenes) Having Hydroxyl Groups," *Macromolecules*, **38(10)**, 4096-4102 (2005).
92. Lin, H., and B.D. Freeman, "Membrane Materials to Remove CO<sub>2</sub> from Gas Mixtures," *Journal of Molecular Structure*, **739(1-3)**, 57-74 (2005).
93. Hill, A.J., B.D. Freeman, M. Jaffe, T.C. Merkel, and I. Pinnau, "Tailoring Nanospace," *Journal of Molecular Structure*, **739(1-3)**, 173-178 (2005).
94. Prabhakar, R.S., T.C. Merkel, B.D. Freeman, T. Imizu, and A. Higuchi, "Sorption and Transport Properties of Propane and Perfluoropropane in Poly(dimethylsiloxane) and Poly(1-trimethylsilyl-1-propyne)," *Macromolecules*, **38(5)**, 1899-1910 (2005).
95. Prabhakar, R.S., Raharjo, R., Toy, L.G., Lin, H., and Freeman, B.D., "Self-Consistent Model of Concentration and Temperature Dependence of Permeability in Rubbery Polymers," *Industrial & Engineering Chemistry Research*, **44**, 1547-1558 (2005).
96. Worrel, L.S., J.A. Morehouse, D.R. Lloyd, B. Freeman, D.F. Lawler, "Modeling Membrane Behavior During Stretching," Membrane Technology Conference & Exposition, Proceedings, Phoenix, AZ, Mar. 6-9, 2005, 1472-1479 (2005).
97. Shimko, L.A., L.S. Worrel, J.A. Morehouse, D.F. Lawler, D.R. Lloyd, B.D. Freeman, "Membrane Stretching. Impact on Flux and Particle Rejection," Membrane Technology Conference & Exposition, Proceedings, Phoenix, AZ, Mar. 6-9, 2005, 59-63 (2005).
98. Baschetti, M. G., G.C. Sarti, F. Doghieri, F., B. Freeman, "Transient and Steady State Effective Diffusivity in High Free Volume Glassy Polymers," World Congress of Chemical Engineering, 7<sup>th</sup>, Glasgow, United Kingdom, July 10-14, 2005, 82456/1-82456/10 (2005).
99. De Angelis, M. G., G.C. Sarti, F. Doghieri, and B.D. Freeman, "Alkane-fluoroalkane Interactions in Polymeric Solutions," World Congress of Chemical Engineering, 7<sup>th</sup>, Glasgow, United Kingdom, July 10-14, 2005 83577/1-83577/10 (2005).
100. Sagle, A., and B. Freeman, "Fundamentals of Membranes for Water Treatment," in *The Future of Desalination in Texas: Volume 2*, Report Number 363, Texas Water Development Board, Austin, TX, pp. 137-154 (2004).
101. Hill, A.J., S.J. Pas, T.J. Bastow, M.I. Burgar, K. Nagai, L.G. Toy, and B.D. Freeman, "Influence of Methanol Conditioning and Physical Aging on Carbon Spin-Lattice Relaxation Times of Poly(1-trimethylsilyl-1-propyne)," *Journal of Membrane Science*, **243(1-2)**, 37-44 (2004).

102. Prabhakar, R.S., B.D. Freeman, and I. Roman, "Gas and Vapor Sorption and Permeation in Poly(2,2,4-trifluoro-5-trifluoromethoxy-1,3-dioxole-co-tetrafluoroethylene)," *Macromolecules*, **37(20)**, 7688-7697 (2004).
103. Lin, H., B.D. Freeman, L. Toy, V. Bondar, R. Gupta, S. Gupta, A. Hill, "Reverse-selective Polymeric Membranes for Hydrogen Purification," *Polymer Preprints (American Chemical Society, Division of Polymer Chemistry)*, **45(2)**, 22-23 (2004).
104. Lin, H., and B.D. Freeman, "Gas Solubility, Diffusivity, and Permeability in Poly(ethylene oxide)," *Journal of Membrane Science*, **239**, 105-117 (2004).
105. Nagai, K., A. Sugawara, S. Kazama, and B.D. Freeman, "Effects of Physical Aging on Solubility, Diffusivity, and Permeability of Propane and *n*-Butane in Poly(4-methyl-2-pentyne)," *Journal of Polymer Science: Part B, Polymer Physics*, **42**, 2407-2418 (2004).
106. Dhoot, S.N. B.D. Freeman, M.E. Stewart, "Sorption and Transport of Linear and Branched Ketones in Biaxially Oriented Polyethylene Terephthalate," *Polymer*, **45(16)**, 5619-5628 (2004).
107. Wang, X.-Y., K.M. Lee, Y. Lu, M.T. Stone, I.C. Sanchez, and B.D. Freeman, "Cavity Size Distributions in High Free Volume Glassy Polymers by Molecular Simulation," *Polymer*, **45(11)**, 3907-3912 (2004).
108. Dhoot, S.N. B.D. Freeman, M.E. Stewart, "Sorption and Transport of Linear Esters and Branched Alkanes in Biaxially Oriented Poly(ethylene terephthalate)," *Industrial & Engineering Chemistry Research*, **43(12)**, 2966-2976 (2004).
109. Prabhakar, R.S., B.D. Freeman, "Fluoropolymer-hydrocarbon Polymer Composite Membranes for Natural Gas Separation," ACS Symposium Series 876 (Advanced Materials for Membrane Separations), 106-128 (2004).
110. Freeman, B.D.; Pinnau, I., "Gas and Liquid Separations Using Membranes: An Overview," ACS Symposium Series 876 (Advanced Materials for Membrane Separations), 1-23 (2004).
111. Dhoot, S.N., B.D. Freeman, "Kinetic Gravimetric Sorption of Low Volatility Gases and Vapors in Polymers," *Review of Scientific Instruments*, **74(12)**, 5173-5178 (2003).
112. Merkel, T.C., Z. He, I. Pinnau, B.D. Freeman, P. Meakin, A.J. Hill, "Sorption and Transport in Poly(2,2-bis(trifluoromethyl)-4,5-difluoro-1,3-dioxole-co-tetrafluoroethylene) Containing Nanoscale Fumed Silica," *Macromolecules*, **36(22)**, 8406-8414 (2003).
113. Merkel, T.C., Z. He, I. Pinnau, B.D. Freeman, P. Meakin, and A.J. Hill, "Effect of Nanoparticles on Gas Sorption and Transport in Poly(1-trimethylsilyl-1-propyne)," *Macromolecules*, **36(18)**, 6844-6855 (2003).
114. Dhoot, S.N., B.D. Freeman, M.E. Stewart "Barrier Polymers" In: Encyclopedia of Polymer Science and Technology, 3rd ed., Volume 5, J. Kroschwitz, editor, John Wiley and Sons, New York, pp. 198-263 (2003). Available online at: <http://www.mrw.interscience.wiley.com/epst/articles/pst025/frame.html>
115. Coker, D.T., R. Prabhakar, and B.D. Freeman, "Gas Separation Using Polymers," *Chemical Engineering Education*, **37(1)**, 60-67 (2003).

116. Ayala, D., A.E. Lozano, J. de Abajo, C. Garcia-Perez, J.G. de la Campa, K.-V. Peinemann, B.D. Freeman, R. Prabhakar, "Gas Separation Properties of Aromatic Polyimides," *Journal of Membrane Science*, **215(1-2)**, 61-73 (2003).
117. Merkel, T. C., B.D. Freeman, R.J. Spontak, Z. He, I. Pinnau, P. Meakin, A.J. Hill, "Sorption, Transport, and Structural Evidence for Enhanced Free Volume in Poly(4-methyl-2-pentyne)/Fumed Silica Nanocomposite Membranes," *Chemistry of Materials*, **15(1)**, 109-123 (2003).
118. DiGiano, F.A., A. Roudman, M.A. Arnold, and B. Freeman, "Novel Block Copolymers as Nanofiltration Materials," *Environmental Engineering and Science*, **19(6)**, 497-511 (2002).
119. Alentiev, A. Yu., V.P. Shantarovich, T.C. Merkel, V.I. Bondar, B.D. Freeman, and Yu.P. Yampolskii, "Gas and Vapor Sorption, Permeation, and Diffusion in Glassy Amorphous Teflon AF1600," *Macromolecules*, **35(25)**, 9513-9522 (2002).
120. Freeman, B.D., T.C. Merkel, I. Pinnau, Z. He, A.J. Hill, and P. Meakin, "Nanocomposites for Vapor Separation," Proceedings of the American Chemical Society, Polymer Division for the 224<sup>th</sup> ACS National Meeting, POLY-371 (2002).
121. Prabhakar, R., B.D. Freeman, "Application of Hydrocarbon-fluorocarbon Interactions in Membrane-based Gas Separations," *Desalination*, **144(1-3)**, 79-83 (2002).
122. Nagai, K., L.G. Toy, B.D. Freeman, M. Teruguchi, G. Kwak, T. Masuda, and I. Pinnau, "Gas Permeability and *n*-Butane Solubility of Poly(1-trimethylgermyl-1-propyne)," *Journal of Polymer Science: Part B, Polymer Physics*, **40**, 2228-2236 (2002).
123. Merkel, T.C., B.D. Freeman, R.J. Spontak, Z. He, I. Pinnau, P. Meakin and A.J. Hill, "Ultraparpermeable, Reverse-Selective Nanocomposite Membranes", *Science*, **296**, 519-522 (2002).
124. De Angelis, M.G., M. Cinti, B.D. Freeman, F. Doghieri, G.C. Sarti, "Sorption and Diffusion of Gases and Vapors in a Perfluorinated Rubber," *PMSE Preprints*, **86**, 133 (2002).
125. Hill, Anita J., P. Meakin, B.D. Freeman, "Modeling the Relationship Between Free Volume and Transport in Polymers: Theory and Experiment," *PMSE Preprints*, **86**, 128-129 (2002).
126. Pinnau, Ingo, B. Freeman, "Polyether-polyamide Block Copolymers: Versatile Materials for Membrane Separations," *PMSE Preprints*, **86**, 108 (2002).
127. Freeman, B., I. Pinnau, "Membranes for Vapor Separations: Recent Advances and Future Directions," *PMSE Preprints*, **86**, 107 (2002).
128. Merkel, T., Toy, L., Coker, D., Gupta, R., Freeman, B.D., Fleming, G., "Removal of Acid Gas Components from Coal-derived Syngas Using Novel, Reverse-selective Membranes," Proceedings – 19<sup>th</sup> Annual International Pittsburgh Coal Conference 713-723 (2002).
129. Arnold, M.E., K. Nagai, B.D. Freeman, R.J. Spontak, D. Leroux, D.E. Betts, J.M. DeSimone, F.A. DiGiano, C.K. Stebbins, and R.W. Linton, "Microphase-Separated Block Copolymers Comprising Low Surface Energy Fluorinated Blocks and Hydrophilic Blocks: Synthesis and Characterization," *Macromolecules*, **35**, 3697-3707 (2002).

130. M.G. De Angelis, T.C. Merkel, V.I. Bondar, B.D. Freeman, F. Doghieri, and G.C. Sarti, "Gas Sorption and Dilation in Poly(2,2-bis(trifluoromethyl)-1,4,5-difluoro-1,3-dioxole-co-tetrafluoroethylene): Comparison of Experimental Data with Predictions of the Non-Equilibrium Lattice Fluid Model," *Macromolecules*, **35**, 1276-1288 (2002).
131. Nagai, K., S. Tanaka, Y. Hirata, T. Nakagawa, M. Arnold, B.D. Freeman, D. LeRoux, D.E. Betts, J.M. DeSimone, and F.A. Digiano, "Solubility and Diffusivity of Sodium Chloride in Phase-Separated Block Copolymers of Poly(2-dimethylaminoethyl methacrylate), Poly(1,1'-dihydroperfluorooctyl methacrylate), and Poly(1,1,2,2-tetrahydroperfluorooctyl acrylate)," *Polymer*, **42(25)**, 9941-9948 (2001).
132. Merkel, T.C., R. Gupta, B. Turk, and B.D. Freeman, "Mixed Gas Permeation of Syngas Components in Poly(dimethylsiloxane) and Poly(1-trimethylsilyl-1-propyne) at Elevated Temperatures," *Journal of Membrane Science*, **191(1-2)**, 85-94 (2001).
133. Merkel, T.C., X. Jiang, H. Lin, N.P. Patel, R.J. Spontak, B.D. Freeman, R. Gupta, and B. Turk, "Mixed Gas Permeation Properties of Synthesis Gas Components in Polymers," *PMSE Preprints*, **85**, 100-101 (2001).
134. Merkel, T.C., B.D. Freeman, X. He, A. Morisato, and I. Pinnau, "Nanocomposites for Gas Separations," *PMSE Preprints*, **85**, 301-302 (2001).
135. Prabhakar, R., T.C. Merkel, B.D. Freeman, T. Imizu, A. Higuchi, G.C. Sarti, and F. Doghieri, "Effect of Fluorocarbon-Hydrocarbon Interactions on Solubility and Permeability Properties of Polymers," *PMSE Preprints*, **85**, 253-254 (2001).
136. Lin, H., X. Jiang, N.P. Patel, R.J. Spontak, and B.D. Freeman, "CO<sub>2</sub>/H<sub>2</sub> Separation Using Polymers," *PMSE Preprints*, **85**, 146-147 (2001).
137. M.E. Arnold, K. Nagai, B.D. Freeman, R.J. Spontak, D.E. Betts, J.M. DeSimone, and I. Pinnau, "Gas Permeation Properties of Poly(1,1'-dihydroperfluorooctylacrylate) (PFOA), Poly(1,1'-dihydroperfluorooctylmethacrylate) (PFOMA) and Poly(styrene-b-FOA) (PS-b-FOA) Copolymers," *Macromolecules*, **34(16)**, 5611-5619 (2001).
138. S.N. Dhoot, B.D. Freeman, M.E. Stewart, and A.J. Hill, "Sorption and Transport of Linear Alkane Hydrocarbons in Biaxially Oriented Polyethylene Terephthalate," *Journal of Polymer Science: Part B, Polymer Physics*, **39**, 1160-1172 (2001).
139. K. Nagai, T. Masuda, T. Nakagawa, B.D. Freeman, and I. Pinnau, "Poly[1-(trimethylsilyl)-1-propyne] and Related Polymers: Synthesis, Properties, and Functions," *Progress in Polymer Science*, **26**, 721-798 (2001).
140. Serad, G.E., B.D. Freeman, M.E. Stewart, and A.J. Hill, "Gas and Vapor Sorption and Diffusion in Poly(ethylene terephthalate)," *Polymer*, **42**, 6929-6943 (2001).
141. Yampolskii, Yu.P., A.P. Korikiv, V.P. Shantarovich, K. Nagai, B.D. Freeman, T. Masuda, M. Teraguchi, and G. Kwak, "Gas Permeability and Free Volume of Highly Branched Substituted Polyacetylenes," *Macromolecules*, **34(6)**, 1788-1796 (2001).
142. Sunderrajan, S., B.D. Freeman, C.K. Hall, and I. Pinnau, "Propane and Propylene Sorption in Solid Polymer Electrolytes Based on Poly(ethylene oxide) and Silver Salts," *Journal of Membrane Science*, **182(1-2)**, 1-12 (2001).

143. G. Kwak, T. Aoki, L.G. Toy, B.D. Freeman, and T. Masuda, "Synthesis, Characterization, and Oxygen Permeability of Homo- and Copolymers from *p*-[Tris(trimethylsilyl)silyl]-phenylacetylene," *Polymer Bulletin*, **45**, 215-221 (2000).
144. Yampol'skii, Y.P., V.G. Berezkin, T.P. Popova, A.P. Korikov, B.D. Freeman, V.I. Bondar, and T.C. Merkel, "Thermodynamics of Gas and Vapor Sorption by Amorphous Glassy AF Teflons," *Vysokomolekuliarnye soedineniia* (Polymer Science. Series A), **42(6)**, 679-688 (June 2000).
145. DiGiano, F. A., B.D. Freeman, J.M. DeSimone, M. Arnold, K. Nagai, J. Preston, A. Roudman, "Relating Membrane Synthesis to Membrane Performance" Prepr. Ext. Abstr. ACS Natl. Meet., Am. Chem. Soc., Div. Environ. Chem. **40(2)**, 293-295 (2000).
146. Bondar, V.I., B.D. Freeman, and I. Pinnau, "Gas Transport Properties of Poly(ether-b-amide) Segmented Block Copolymers," *Journal of Polymer Science: Part B, Polymer Physics*, **38(15)**, 2051-2062 (2000).
147. Higuchi, A., T. Yoshida, T. Imizu, K. Mizoguchi, Z. He, I. Pinnau, K. Nagai, and B.D. Freeman, "Gas Permeation of Fullerene-Dispersed Poly(1-trimethylsilyl-1-propyne) Membranes," *Journal of Polymer Science: Part B, Polymer Physics*, **38**, 1749-1755 (2000).
148. Dixon-Garrett, S.V., B.D. Freeman, and K. Nagai, "Ethylbenzene Solubility, Diffusivity, and Permeability in Poly(dimethylsiloxane)," *Journal of Polymer Science: Part B, Polymer Physics*, **38**, 1461-1473 (2000).
149. Nagai, K., L.G. Toy, B.D. Freeman, M. Teraguchi, T. Masuda, and I. Pinnau, "Gas Permeability and Hydrocarbon Solubility of Poly[1-phenyl-2-[*p*-(triisopropylsilyl)phenyl]acetylene]," *Journal of Polymer Science: Part B, Polymer Physics*, **38**, 1474-1484 (2000).
150. Nagai, K., B.D. Freeman, A. Cannon, and H.R. Allcock, "Gas Permeability of Poly(bis-trifluoroethoxy phosphazene) and Adamantane-bearing Polyphosphazene," *Journal of Membrane Science*, **172**, 167-176 (2000).
151. Higuchi, A., T. Agatsuma, S. Uemiya, T. Kojima, K. Mizoguchi, I. Pinnau, K. Nagai, B.D. Freeman, "Preparation and Gas Permeation of Immobilized Fullerene Membrane," *Journal of Applied Polymer Science*, **77**, 529-537 (2000).
152. Nagai, K., B.D. Freeman, and A.J. Hill, "Effect of Physical Aging of Poly(1-trimethylsilyl-1-propyne) Films Synthesized Using TaCl<sub>5</sub> and NbCl<sub>5</sub> on Gas Permeability, Fractional Free Volume, and Positron Annihilation Lifetime Spectroscopy Parameters," *Journal of Polymer Science: Part B, Polymer Physics*, **38(9)**, 1222-1239 (2000).
153. Dixon-Garrett, S.V., B.D. Freeman, and K. Nagai, "Sorption, Diffusion, and Permeation of Ethylbenzene in Poly(1-trimethylsilyl-1-propyne)," *Journal of Polymer Science: Part B, Polymer Physics*, **38(8)**, 1078-1089 (2000).
154. Toy, L.G., K. Nagai, B.D. Freeman, I. Pinnau, Z. He, T. Masuda, M. Teraguchi, and Yu.P. Yampolskii, "Pure-Gas and Vapor Permeation and Sorption Properties of Poly[1-phenyl-2-[*p*-(trimethylsilyl)phenyl]acetylene] (PTMSDPA)," *Macromolecules*, **33**, 2516-2524 (2000).
155. Merkel, T.C., V.I. Bondar, K. Nagai, B.D. Freeman, and I. Pinnau, "Gas Sorption, Diffusion, and Permeation in Poly(dimethylsiloxane)," *Journal of Polymer Science: Part B, Polymer Physics*, **38**, 415-434 (2000).

156. Merkel, T.C., V. Bondar, K. Nagai, and B.D. Freeman, "Sorption and Transport of Hydrocarbon and Perfluorocarbon Gases in Poly(1-trimethylsilyl-1-propyne)," *Journal of Polymer Science: Part B, Polymer Physics*, **38(2)**, 273-296 (2000).
157. Pinnau, I. and B.D. Freeman, "Membrane Formation and Modification Methods-Overview and Future Developments," in *Membrane Formation and Modification*, Edited by I. Pinnau and B.D. Freeman, ACS Symposium Series Volume 744, American Chemical Society, Washington, DC, 1-22 (2000).
158. Merkel, T.C., V. Bondar, K. Nagai, B.D. Freeman, and Yu.P. Yampolskii, "Gas Sorption, Diffusion and Permeation in Poly(2,2-bis(trifluoro-methyl-4,5-difluoro-1,3-dioxole-co-tetrafluoroethylene)," *Macromolecules*, **32(25)**, 8427-8440 (1999).
159. De Angelis, M.G., T.C. Merkel, V.I. Bondar, B.D. Freeman, F. Doghieri, and G.C. Sarti, "Hydrocarbon and Fluorocarbon Solubility and Dilution in Poly(dimethylsiloxane): Comparison of Experimental Data with Predictions of the Sanchez-LaCombe Equation of State," *Journal of Polymer Science: Part B, Polymer Physics*, **37(21)**, 3011-3026 (1999).
160. McDowell, C.C., B.D. Freeman, and G.W. McNeely, "Interval Kinetic Gravimetric Sorption of Acetone in Random Copolymers of Poly(ethylene terephthalate) and Poly(ethylene 2,6-naphthalate)," *Journal of Polymer Science: Part B, Polymer Physics*, **37(21)**, 2973-2984 (1999).
161. DiGiano, F.A., A. Roudman, B. Freeman, M. Arnold, K. Nagai, "Microscale Modeling of Experimental Block Copolymer Behavior to Predict Nanofiltration Performance," Proceedings of the Annual Conference of the American Water Works Association, 13-24 (1999).
162. DiGiano, F.A., B. Freeman, M. Arnold, J. Preston, K. Nagai, A. Roudman, "Membrane characterization and membrane material optimization," Environ. Eng. 1999, Proceedings of the ASCE-CSCE Natl. Conf., 217-226 (1999).
163. Havelka, P.A., K. Nagai, B.D. Freeman, and V.V. Sheares, "Synthesis and Characterization of Poly[[1,1'-biphenyl]-4,4'-diyl[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]]," *Macromolecules*, **32(20)**, 6418-6424 (1999).
164. Sunderrajan, S., B.D. Freeman, and C.K. Hall, "Fourier Transform Infrared Spectroscopic Characterization of Olefin Complexation by Silver Salts in Solution," *Industrial & Engineering Chemistry Research*, **38(10)**, 4051-4059 (1999).
165. Bondar, V.I., B.D. Freeman, and Yu.P. Yampolskii, "Sorption of Gases and Vapors in an Amorphous Glassy Perfluorodioxole Copolymer," *Macromolecules*, **32**, 6163-6171 (1999).
166. McDowell, C.C., J.M. Partin, B.D. Freeman, G.W. McNeely, "Acetone Solubility and Diffusivity in Poly(ethylene terephthalate) Modified with Low Levels of 2,6-naphthalene Dicarboxylic Acid, Isophthalic Acid, and 2,5-bis-(4-carboxyphenyl)-1,3,4-oxadiazole," *Journal of Membrane Science*, **163(1)**, 39-49 (1999).
167. Nagai, K., L.G. Toy, B.D. Freeman, M. Teraguchi, T. Masuda, "Influence of Physical Aging and Methanol Conditioning on Gas Permeability and Hydrocarbon Solubility of Poly[1-phenyl-2-[p-(triisopropylsilyl)phenyl]acetylene] (PTPSDPA)," *PMSE Preprints*, **81**, 531-532 (1999).
168. Hill, A.J., K. Nagai, B.D. Freeman, "Physical Aging of High Permeability Membrane Polymers," *PMSE Preprints*, **81**, 526-527 (1999).

169. Sheares, V.V., P. Havelka, K. Nagai, B.D. Freeman, "Gas Permeability Properties of Poly(1,1'-biphenyl)-4,4'-diyl[2,2,2-trifluoro-1-(trifluoromethyl)ethylidene]," *PMSE Preprints*, **81**, 533-534 (1999).
170. Freeman, B.D., C. Noël, and A.J. Hill, "The Influence of Annealing on Thermal Transitions and Barrier Properties of Nematic Copolyesters," *Proceedings of the American Chemical Society Polymer Division*, **40(2)**, 478-479 (1999).
171. Bondar, V.I., B.D. Freeman, and I. Pinnau, "Gas Sorption and Characterization of Poly(ether-*b*-amide) Segmented Block Copolymers," *Journal of Polymer Science: Part B, Polymer Physics*, **37**, 2463-2475 (1999).
172. Coker, D.T., T. Allen, B.D. Freeman, and G.K. Fleming, "Nonisothermal Model for Gas Separation Hollow Fiber Membranes," *American Institute for Chemical Engineers Journal*, **45(7)**, 1451-1468 (1999).
173. Singh, A., K. Ghosal, J.G. de la Campa, A.E. Lozano, J. De Abajo and B.D. Freeman, "Gas Separation Properties of Aromatic Polyamides Containing Sulfone and Hexafluoro-isopropylidene Groups," *Polymer*, **40**, 5715-5722 (1999).
174. Nagai, K., B.D. Freeman, T. Watanabe, and T. Nakagawa, "Effects of Physical Aging on Gas Permeability and Molecular Motion in Poly(1-trimethylsilyl-1-propyne)," in *Polymeric Membranes for Gas and Vapor Separations: Chemistry and Materials Science*, Edited by B.D. Freeman and I. Pinnau, ACS Symposium Series Volume 733, American Chemical Society, Washington, DC, pp. 95-101 (1999).
175. Freeman, B.D. and I. Pinnau, "Polymeric Materials for Gas Separations," in *Polymeric Membranes for Gas and Vapor Separations: Chemistry and Materials Science*, Edited by B.D. Freeman and I. Pinnau, ACS Symposium Series Volume 733, American Chemical Society, Washington, DC, pp. 1-27 (1999).
176. McDowell, C.C., G. McNeely, and B.D. Freeman, "Acetone Sorption and Uptake Kinetics in Poly(ethylene terephthalate)," *Polymer*, **40**, 3487-3499 (1999).
177. Cantrell, G.R., C.C. McDowell, B.D. Freeman, and C. Noël, "The Influence of Annealing on Thermal Transitions in a Nematic Copolyester," *Journal of Polymer Science: Part B, Polymer Physics*, **37(6)**, 505-522 (1999).
178. Freeman, B.D., "Basis of Permeability/Selectivity Tradeoff Relations in Polymeric Gas Separation Membranes," *Macromolecules*, **32**, 375-380 (1999).
179. Merkel, T., V. Bondar, K. Nagai, B.D. Freeman, "Perfluorocarbon Sorption in Polydimethylsiloxane, Poly(1-trimethylsilyl)-1-propyne, and Random Copolymers of Tetrafluoroethylene and 2,2-bistrifluoromethyl-4,5-difluoro-1,3-dioxole," *Macromolecules*, **32**, 370-374 (1999).
180. Freeman, B.D., and A.J. Hill, "Free Volume and Transport Properties of Barrier and Membrane Polymers," in *Structure and Properties of Glassy Polymers*, Edited by M.R. Tant and A.J. Hill, ACS Symposium Series Volume 710, American Chemical Society, Washington, DC, pp. 306-325 (1999).

181. Yampolskii, Yu.P., M.V. Motyakin, A.M. Wasserman, T. Masuda, M. Teraguchi, V.S. Khotimskii, B.D. Freeman, "Study of High Permeability Polymers by Means of the Spin Probe Technique," *Polymer*, **40**, 1745-1752 (1999).
182. McDowell, C.C., B.D. Freeman, G.W. McNeely, M.I. Haider, and A.J. Hill, "Synthesis, Physical Characterization, and Acetone Sorption Kinetics in Random Copolymers of Poly(ethylene terephthalate) and Poly(ethylene 2,6-naphthalate)," *Journal of Polymer Science: Part B, Polymer Physics*, **36(16)**, 2981-3000 (1998).
183. Smith, S.W., C.K. Hall, B.D. Freeman, and J.A. McCormick, "Self Diffusion Coefficients and Atomic Mean-Squared Displacements in Entangled Hard Chain Fluids," in Numerical Methods for Polymeric Systems, S.G. Whittington, Ed., Springer-Verlag, New York, 203-215 (1998).
184. Merkel, T., V. Bondar, K. Nagai, M.G. DeAngelis, B. Freeman, and F. Doghieri, "Hydrocarbon and Perfluorocarbon Vapor Sorption in Rubbery and Glassy Hydrocarbon-Based Polymers and Fluoropolymers," *ACS Polymer Preprints*, **39(2)**, 916-917 (1998).
185. Yampolskii, Y.P., A. Y. Alentiev, S.M. Shishatskii, V.P. Shantarovich, B.D. Freeman, and V.I. Bondar, "Fluorine Containing Polymers - Materials for Gas Separating Membranes," *ACS Polymer Preprints*, **39(2)**, 884-885 (1998).
186. Freeman, B.D. "Gas Separations Using Polymers," Chapter 4 in Advances in Chemical and Refining Separations Technology, Edited by C. Payn, The Catalyst Group, Spring House, PA, (1998).
187. Freeman, B., K. Nagai, T. Merkel, V. Bondar, M.G. De Angelis, F. Doghieri, G. Sarti, "Sorption, Diffusion, and Permeation of Perfluorocarbon Vapors and Their Hydrocarbon Analogs in High Free Volume Glassy Polymers," *Polymer Preprints, Japan*, **47(6)**, 1079-1080 (1998).
188. McDowell, C.C., D.T. Coker, and B.D. Freeman, "An Automated Spring Balance for Kinetic Gravimetric Sorption of Gases and Vapors in Polymers," *Review of Scientific Instruments*, **69(6)**, 2510-2513, June 1998.
189. Coker, D.T., B.D. Freeman, and G.K. Fleming, "Modeling Multicomponent Gas Separation Using Hollow Fiber Membrane Contactors," *American Institute for Chemical Engineers Journal*, **44(6)**, 1289-1302, June 1998.
190. Huang, S.J., C.J. Durning, and B.D. Freeman, "Modeling Weakly Non-linear Two-stage Sorption Kinetics in Glassy Polymer Films," *Journal of Membrane Science*, **143**, pp. 1-11 (1998).
191. Singh, A., B.D. Freeman, and I. Pinnau, "Pure and Mixed Gas Acetone/Nitrogen Permeation Properties of Poly(dimethylsiloxane) [PDMS]," *Journal of Polymer Science: Part B, Polymer Physics*, **36**, 289-301 (1998).
192. Pinnau, I., C.G. Casillas, A. Morisato, and B.D. Freeman, "Long-Term Permeation Properties of Poly(1-trimethylsilyl-1-propyne) Membranes in Organic Vapor Environment," *Journal of Polymer Science: Part B, Polymer Physics*, **35(10)**, 1483-1490 (1997).
193. Sunderrajan, S., C.K. Hall, and B.D. Freeman, "Chemical Potential Gradient Driven Permeation of Small Molecules through Polymeric Media," *Journal of Chemical Physics*, **107(24)**, 10714-10722 (1997).

194. Bondar, V., A. Singh, and B.D. Freeman, "Gas Sorption and Transport Properties of Poly(tetrafluoroethylene-co-2,2-bis(trifluoromethyl)-4,5-difluoro-1,3-dioxole)," *AIChE Topical Conference on Separation Science and Technologies*, **2**, 831-837 (1997).
195. Toy, L.G., B.D. Freeman, R.J. Spontak, A. Morisato, and I. Pinnau, "Gas Permeability and Phase Morphology of Poly(1-trimethylsilyl-1-propyne)/Poly(1-phenyl-1-propyne) Blends," *Macromolecules*, **30(16)**, 4766-4769 (1997).
196. Freeman, B.D. and I. Pinnau, "Separation of Gases Using Solubility-Selective Polymers," *Trends in Polymer Science*, **5(5)**, 167-173 (1997).
197. Sunderrajan, S., C.K. Hall, and B.D. Freeman, "Sorption Isotherms for Spherical Penetrants in Facilitating Polymeric Media Using Monte Carlo Simulations," *Molecular Physics*, **92(1)**, 109-116 (1997).
198. Smith, S.W., C.K. Hall, and B.D. Freeman, "Molecular Dynamics for Polymeric Fluids Using Discontinuous Potentials," *Journal of Computational Physics*, **134**, 16-30 (1997).
199. Smith, S.W., C.K. Hall, and B.D. Freeman, "Pressure-Dependent Photon-Correlation Spectroscopic Investigation of Poly(propylene oxide) Near the Glass Transition," *Macromolecules*, **30(7)**, 2052-2057 (1997).
200. Sunderrajan, S., I. Pinnau, and B.D. Freeman, "Sorption and Spectroscopic Analysis of Silver-Olefin Interaction in Polymer Electrolytes," *PMSE Preprints*, **77**, 267-268 (1997).
201. Toy, L.G., B.D. Freeman, A. Morisato, I. Pinnau, T. Masuda, and M. Teraguchi, "Pure-Gas Permeation and Sorption Properties of High-Free-Volume, Vapor-Selective, Glassy Polyacetylenes," *PMSE Preprints*, **77**, 256-257 (1997).
202. A. Singh, V. Bondar, S. Dixon, B.D. Freeman, and A.J. Hill, "Gas Sorption, Transport Properties, and PALS Analysis of Poly(tetrafluoroethylene [TFE]-co-2,2-bis(trifluoromethyl)-4,5-difluoro-1,3-dioxole [PDD])," *PMSE Preprints*, **77**, 316-317 (1997).
203. Bondar, V.I., B.D. Freeman, and I. Pinnau, "Characterization and Analysis of the Sorption and Pure-Gas Permeation Properties of Polyether-Polyamide Block Copolymers," *PMSE Preprints*, **77**, 311-312 (1997).
204. Nagai, K., B.D. Freeman, T. Watanabe, and T. Nakagawa, "The Effect of Physical Aging on Permeability and Molecular Motion of Poly[1-trimethylsilyl-1-propyne] Membrane," *PMSE Preprints*, **77**, 253-254 (1997).
205. Pinnau, I., L.G. Toy, S. Sunderrajan, and B.D. Freeman, "Solid Polymer Electrolyte Membranes for Olefin/Paraffin Separation," *PMSE Preprints*, **77**, 269-270 (1997).
206. Freeman, B.D., "Transport Properties of Stiff Chain Glassy Polymers," *Polymer Preprints, ACS Division of Polymer Chemistry*, **76**, 423-424 (1997).
207. Smith, S.W., C.K. Hall, and B.D. Freeman, "Reply to Comment on Molecular Dynamics Study of Entangled Hard Chain Fluids," *Physical Review Letters*, **76**, 4449 (1996).
208. Pinnau, I., C.G. Casillas, A. Morisato, and B.D. Freeman, "Hydrocarbon/Hydrogen Mixed-Gas Permeation in Poly(1-trimethylsilyl-1-propyne) [PTMSP], poly(1-phenyl-1-propyne) [PPP] and

- PTMSP/PPP Blends,” *Journal of Polymer Science: Part B, Polymer Physics*, **34(15)**, 2613-2621 (1996).
209. Morisato, A., B.D. Freeman, C.G. Casillas, and I. Pinnau, “Pure Hydrocarbon Sorption Properties of Poly(1-trimethylsilyl-1-propyne) [PTMSP], poly(1-phenyl-1-propyne) [PPP] and PTMSP/PPP Blends,” *Journal of Polymer Science: Part B, Polymer Physics*, **34**, 1925-1934 (1996).
  210. Ghosal, K., R.T. Chern, B.D. Freeman, W.H. Daly, and I.I. Negulescu, “The Effect of Basic Substituents on Gas Sorption and Permeation in Polysulfone,” *Macromolecules*, **29(12)** 4360-4369 (1996).
  211. Shen, H.C., C. McDowell, S.S. Sankar, B.D. Freeman, R.J. Kumpf, D.A. Wicks, C.W. Lantmann, and C. Noël, “Synthesis and Thermal Transitions of a New Soluble Main Chain Nematic Liquid Crystalline Polymer,” *Journal of Polymer Science: Part B, Polymer Physics*, **34**, 1347-1361 (1996).
  212. Sunderrajan, S., C.K. Hall, and B.D. Freeman, “Estimation of Mutual Diffusion Coefficients in Polymer/Penetrant Systems Using Nonequilibrium Molecular Dynamics Simulations,” *Journal of Chemical Physics*, **105(4)**, 1621-1632 (1996).
  213. Morisato, A., H.-C. Shen, S. Sankar, B.D. Freeman, C.G. Casillas, and I. Pinnau, “Polymer Characterization and Gas Permeability of Poly(1-trimethylsilyl-1-propyne) [PTMSP], poly(1-phenyl-1-propyne) [PPP] and PTMSP/PPP Blends,” *Journal of Polymer Science: Part B, Polymer Physics*, **34**, 2209-2222 (1996).
  214. Freeman, B.D., “Calculated Performance of Hollow Fiber Modules for H<sub>2</sub>/CH<sub>4</sub> Gas Separation Using Aromatic Polyamide Membranes,” *The 1996 Membrane Technology Reviews*, edited by D. Mulloy, Business Communications Co., Norwalk, CT, 129-140 (1996).
  215. Smith, S.W., C.K. Hall, and B.D. Freeman, “Molecular Dynamics Study of Entangled Hard-Chain Fluids,” *Journal of Chemical Physics*, **104(18)**, 5616-5637 (1996).
  216. Shen, H.C., C.C. McDowell, B.D. Freeman, and C. Noël, “Thermal Transitions and Structure Evolution in PICT, a Soluble Nematic LCP Exhibiting a Kinetically Trapped, Disordered Microstructure,” *Polymer Preprints*, ACS Division of Polymer Chemistry, **37(1)** 90-91(1996).
  217. Hill, A.J., B.D. Freeman, C.C. McDowell, and M. Jaffe, “The Role of Free Volume in the Room Temperature Transport Properties of Aromatic Copolyesters: the As-Cast Isotropic State as Compared to the Annealed Nematic State,” *Proc. of IMSTEC '96*, Vol. 2, A. G. Fane Ed. (UNESCO Centre for Membrane Science and Tech: Sydney, 38-40 (1996).
  218. Smith, S.W., C.K. Hall, and B.D. Freeman, “Large-Scale Molecular Dynamics Study of Entangled Hard-Chain Fluids,” *Physical Review Letters*, **75(7)**, 1316-1319 (1995).
  219. Smith, S.W., B.D. Freeman, C.K. Hall, and R. Rautenbach, “Analytical Gas-Permeation Models for Binary Gas Mixture Separation Using Membrane Modules,” *Journal of Membrane Science*, **118**, 289-294 (1996).
  220. Morisato, A., K. Ghosal, B.D. Freeman, R.T. Chern, J.C. Alvarez, J.G. de la Campa, A.E. Lozano and J. de Abajo, “Gas Separation Properties of Aromatic Polyamides Containing Hexafluoroisopropylidene Groups,” *Journal of Membrane Science*, **104(3)**, 231-241 (1995).

221. Freeman, B.D., "Osmosis," in *Encyclopedia of Applied Polymer Physics*, **13**, 59-71 (1995).
222. Ghosal, K., B.D. Freeman, R.T. Chern, J.C. Alvarez, J.G. de la Campa, A.E. Lozano, and J. de Abajo, "Gas Separation Properties of Aromatic Polyamides with Sulfone Groups," *Polymer*, **36(4)**, 793-800 (1995).
223. Ghosal, K., R.T. Chern, and B.D. Freeman, "The Effect of Aryl Nitration on Gas Sorption and Permeation in Polysulfone," *Journal of Polymer Science: Part B, Polymer Physics*, **33**, 657-666 (1995).
224. Smith, S.W., C.K. Hall, and B.D. Freeman, "Molecular Dynamics Study of Transport Coefficients for Hard-chain Fluids," *Journal of Chemical Physics*, **102(2)**, 1057-1073 (1995).
225. Freeman, B., M. Arnold, J.M. DeSimone, R. Linton, D. Betts, and C. Kassis, "Gas Transport and Surface Segregation of Polymer Membranes Based on Poly(1,1'-dihydroperfluorooctylacrylate)," *MARIENV'95 Conference Proceedings* (1995).
226. Freeman, B.D., A. Singh, and A. Morisato, I. Pinnau and C.G. Casillas, "Novel Polymer Membranes for Recovery of VOCs and Fluorocarbons from Air Streams," *MARIENV'95 Conference Proceedings* (1995).
227. Ghosal, K. and B.D. Freeman, "Gas Separations Using Polymeric Membranes: An Overview," *Polymers for Advanced Technologies*, **5(11)**, 673-697 (1994).
228. A. Morisato, N.R. Miranda, J.T. Willits, G.R. Cantrell, B.D. Freeman, H.B. Hopfenberg, S. Makhija, I. Haider, and M. Jaffe, "The Sensitivity of Small Molecule Sorption Properties to Morphology in Glassy Liquid Crystalline Polymers," in *Crystallization and Related Phenomena in Amorphous Materials: Ceramics, Metals, Polymers, and Semiconductors*, edited by M. Libera, P. Cebe, T. Haynes, and J. Dickinson, Mat. Res. Soc. Symp. Proc. Vol. 321, 81-86 (1994).
229. Cantrell, G.R., B.D. Freeman, H.B. Hopfenberg, S. Makhija, I. Haider, and M. Jaffe, "The Influence of Thermal Annealing on Organic Vapor Sorption and Transport in a Nematogenic Copolyester," in *Liquid Crystalline Polymers*, C. Carfagna, Editor, Pergamon Press, New York, 233-251 (1994).
230. Miranda, N.R., B.D. Freeman, and H.B. Hopfenberg, "Organic Vapor Sorption and Transport in a Thermotropic Liquid Crystalline Polyester," *Journal of Membrane Science*, **94(1-3)**, 67-83 (1994).
231. Freeman, B., M. Arnold, J. DeSimone, R. Linton, D. Betts, C. Kassis, Z. Guan, J. Steehler, "Very Low Surface Energy Heterophase Polymeric Materials for Membrane Separations," *Proceedings of the US-Japan Technical Workshop on Shipboard Wastes Treatment Technology*, 2-20 to 2-25 (1994).
232. Freeman, B.D., "Editorial: Gas Separations Using Polymeric Membranes," *Polymers for Advanced Technologies*, **5(11)**, 671-672 (1994).
233. Ghosal, K., Morisato, A., Freeman, B.D., Chern, R.T., Alvarez, J.C., de la Campa, J.G., and de Abajo, J., "Synthesis and Gas Separation Properties of a Family of New Aromatic Polyamides for Petrochemical Applications," *Polymer Preprints*, ACS Division of Polymer Chemistry, **35(1)**, 712-713 (1994).

234. Hariharan, R., R.G. Carbonell, B.D. Freeman, and G.C. Sarti, "Equation of State Predictions of Sorption Isotherms in Polymeric Materials," *Journal of Applied Polymer Science*, **50**, 1781-1795 (1993).
235. Morisato, A., B.D. Freeman, H.B. Hopfenberg, G. Costa and S. Russo, "The Influence of Chain Configuration and, in Turn, Chain Packing on the Sorption and Transport Properties of Poly(*tert*-butyl acetylene)," *Journal of Applied Polymer Science*, **49**, 2065-2074 (1993).
236. Ghosal, K., R.T. Chern, and B.D. Freeman, "Gas Permeability of Radel A Polysulfone," *Journal of Polymer Science: Part B, Polymer Physics*, **31**, 891-893 (1993).
237. Hariharan, R., R.G. Carbonell, B.D. Freeman, and G.C. Sarti, "Equation of State Predictions of Sorption Isotherms in Polymeric Melts," *Fluid Phase Equilibria*, **83**, 407-414, (1993).
238. Ghosal, K., R.T. Chern, and B.D. Freeman, "The Effect of Aryl Nitration on Gas Sorption and Permeation in Polysulfone," *Advances in Filtration and Separation Technology*, Leung, W.W.F., Ed., **7**, 372-375 (1993).
239. Cantrell, G.R., Freeman, B.D., and Hopfenberg, H.B., "The Effect of Thermal Annealing on the Sorption and Transport Behavior of Liquid Crystalline Polymeric Barrier Materials," *Polymer Preprints*, ACS Division of Polymer Chemistry, **34(1)**, 894-895 (1993).
240. Roos, F.H., W.H. Daly, I.I. Negulescu, M.N. Aniano-Ilaio, K. Ghosal, and B.D. Freeman, "Synthesis, Characterization, and Potential Applications of Some Substituted Aromatic Poly(ether sulfone)s," *PMSE Preprints*, **69**, pp. 556-557 (1993).
241. Freeman, B.D., "Mutual Diffusion in Polymers," *Comprehensive Polymer Science, First Supplement*, Aggarwal, S.L. and S. Russo, Editors, Pergamon Press, New York, pp. 167-198, (1992).
242. Bokobza, L., L. Monnerie, and B.D. Freeman, "Investigation of Polymer Dynamics Through the Intramolecular Excimer Formation of Small Probes: Temperature and Pressure Effects," *Polymer Preprints*, ACS Division of Polymer Chemistry, **33(1)**, 816-817 (1992).
243. Costa, G., Gattiglia, E., Grosso, A., Russo, S., Freeman, B.D., and Hopfenberg, H.B., "Poli(*t*-butilacetilene): Effetto Delle Condizioni di Sintesi Sulla Struttura et Sulle Proprieta' di Trasporto," Proceedings of the AIM (Italian Macromolecular Association) (1992).
244. Ghosal, K., R.T. Chern, B.D. Freeman, W.H. Daly, I.I. Negulescu, and R. Savariar, "The Effect of Aryl Amination and Nitration on Gas Sorption, Diffusion, and Permeation in Polysulfones," AICHE Meeting, Miami Beach, FL, November 1-6, 1992, *First Separations Division Topical Conference on Separations Technologies: New Developments and Opportunities*, pp. 903-908 (1992).
245. Freeman, B.D., L. Bokobza, P. Sergot, L. Monnerie, and F.C. DeSchryver, "Using the Emission Properties of an Intramolecular Excimer-Forming Probe Molecule to Determine the Effect of Hydrostatic Pressure on Local Polymer Dynamics," *Journal of Luminescence*, **48&49**, 259-264 (1991).
246. Miranda, N.R., B.D. Freeman, and H.B. Hopfenberg, "The Relative Contribution of Adsorption to the Overall Sorption and Transport of Small Molecules in Amber," *Journal of Membrane Science*, **60**, 147-155 (1991).

247. Miranda, A. Morisato, B.D. Freeman, H.B. Hopfenberg, G. Costa and S. Russo, "The Effect of Higher Order Molecular Structure Upon the Sorption and Transport of Small Molecules in Stiff-Chain Glassy Polymers," *Polymer Preprints*, ACS Division of Polymer Chemistry, **32(3)**, 382-383 (1991).
248. Freeman, B.D., L. Bokobza, P. Sergot, L. Monnerie, and F.C. De Schryver, "The Effect of Hydrostatic Pressure on Local Polymer Dynamics in Poly(propylene oxide)," *Macromolecules*, **23(9)**, 2566-2573 (1990).
249. Freeman, B.D., L. Bokobza, and L. Monnerie, "The Effect of Hydrostatic Pressure on Local Polymer Dynamics in Polyisoprene," *Polymer*, **31**, 1045-1050 (1990).
250. Freeman, B.D., D.S. Soane, and M.M. Denn, "Effect of Hydrostatic Pressure on Polystyrene Diffusivity in Toluene," *Macromolecules*, **23**, 245-251 (1990).
251. Freeman, B.D., W. Provine, G.H. Dow, and M.M. Denn, "Design of a Slurry Pipeline," CACHÉ Corporation program library, (1987).
252. Freeman, B.D., M.M. Denn, R. Keunings, G. Molau, and J. Ramos, "Profile Development in Drawn Hollow Tubes," *Journal of Polymer Engineering*, **6**, 171-186 (1986).
253. Devereux, B.M., B.D. Freeman, D.S. Soong, and M.M. Denn, "Simulation of Melt Spinning With Kinetic Network Models," *Proceedings of SPE/ANTEC'85*, 669-671 (1985).

**PATENTS:**

- B.D. Freeman, S. Matteucci, and H. Lin, "Metal Oxide Nanoparticle Filled Polymers," U.S. Patent Number 7,510,595 B2, March 31, 2009.
- J.E. McGrath, B.D. Freeman, and H.B. Park, "Chlorine Resistant Reverse Osmosis Membranes," U.S. Patent Application Number US 2007/0163951 A1, July 19, 2007.
- Emrick, T.S., K. Breitenkamp, R. Revanur, B. McCloskey, and B.D. Freeman, "Cyclooctene Monomers and Polymers, and Water Purification Articles and Methods Utilizing Them," U.S. Patent Application Number US 2008/0142454 A1, June 19, 2008.
- B.D. Freeman, H.B. Park, and B.D. McCloskey, "Water Purification Membranes with Improved Fouling Resistance," U.S. Patent Application Serial Number 61/079,608, July 10, 2008.