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ZACHARY P. SMITH

Professional Appointments

- 2022– Associate Professor (Pre-tenure), Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA.
- 2017–2022 Assistant Professor, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA.
Robert N. Noyce Career Development Chair (2021–2023)
Joseph R. Mares Career Development Chair (2017–2019)
- 2014–2016 Postdoctoral Scholar, Department of Chemistry, University of California, Berkeley, Berkeley, CA.

Education

- 2008–2014 *Ph.D.*, Chemical Engineering, University of Texas at Austin, Austin, TX. Advisors Donald R. Paul and Benny D. Freeman.
- 2008–2011 *M.S.*, Chemical Engineering, University of Texas at Austin, Austin, TX.
- 2004–2008 *B.S. with Honors and Distinction*, Chemical Engineering, Pennsylvania State University, University Park, PA.

Founded Companies

- 2021 Osmoses Inc., Co-Founder and CSO (Winner of MIT \$100k Competition)
- 2017 Flux Technology, Co-Founder

Patents/Patent Applications

8. **Z. P. Smith**, T. Lee, Highly microporous polymer nanofilms by interfacial polymerization of rigid units for ultrafast organic solvent nanofiltration. S/N 63/482,454. *Provisional Patent*.
7. **Z. P. Smith**, G. Han, Thin-film nanocomposite membranes for separating ions and uncharged species in water. S/N 63/342122.
6. T. M. Swager, S. Guo, **Z. P. Smith**, F. M. Benedetti, Poly(aryl ether) based polymers and associated gas separation membranes. US 2022/0282041 A1.
5. H. W. H. Lai, J. M. Ahn, Y. Xia, **Z. P. Smith**, F. M. Benedetti, High-performance ladder polymers for membrane gas separation. US 2022/0411574 A1.
4. **Z. P. Smith**, L. Chi, H. Lee, Branched metal–organic framework nanoparticles and associated methods. US 2021/0130372 A1.
3. **Z. P. Smith**, L. Chi, B. J. Sundell, K. Zhang, S. C. Hayden, D. J. Harrigan, H. Lee, Branched metal–organic framework nanoparticles in mixed-matrix membranes and associated methods. US 11,827,647 B2.
2. T. M. Swager, Y. He, **Z. P. Smith**, S. Lin, F. M. Benedetti, Porous compositions and related methods. US 11,472,915 B2.
1. J. R. Long, J. Bachman, **Z. P. Smith**, Adsorption-enhanced and plasticization resistant composite membranes. US 11,110,405 B2.

Honors and Awards

- 2022 American Institute of Chemical Engineers (AIChE) Kunesh Award
- 2022 National Science Foundation (NSF) CAREER Award

2021	Frank E. Perkins Award for Excellence in Graduate Advising – MIT
2021	Office of Naval Research (ONR) Young Investigator Award
2020	American Institute of Chemical Engineers 35 Under 35 Award
2018	Department of Energy (DOE) Early Career Award
2017	North American Membrane Society Young Membrane Scientist Award
2013	U.S. Delegate to the Lindau Nobel Laureate Meeting on Chemistry
2013	American Chemical Society (ACS) Excellence in Graduate Polymer Research
2010	Department of Energy Office of Science Graduate Fellow

Teaching

2017–2022	<i>10.32 – Separation Processes</i> . Undergraduate course on theory and processes for molecular separations.
	<i>10.40 – Chemical Engineering Thermodynamics</i> . Graduate course covering the principles, concepts, and laws/postulates of classical and statistical thermodynamics.
	<i>10.467 – Polymer Science Lab</i> . Undergraduate laboratory course covering chemistry, physics, and application of polymers.
	<i>10.569 – Synthesis of Polymers</i> . Interdisciplinary graduate level course on polymer synthesis methods and applications.

Supervised Graduate Students

2023–	Lauren Burton, Chemical Engineering, MIT, <i>Ph.D.</i>
2023–	Megan Herrington, Chemical Engineering, MIT, <i>Ph.D.</i>
2023–	Tom Goodwin, Chemical Engineering, MIT, <i>Ph.D.</i> (Co-advised with Fikile Brushett)
2023–	Yein Yoon, Chemical Engineering, MIT, <i>Ph.D.</i>
2023–	Brenda Zhao, Chemical Engineering, MIT, <i>Ph.D.</i>
2022–	Erin Sturd, Chemical Engineering, MIT, <i>Ph.D.</i>
2021–	Philippe Jean-Baptiste, Chemical Engineering, MIT, <i>Ph.D.</i>
2020–	Simar Mattewal, Chemical Engineering, MIT, <i>Ph.D.</i> (Co-advised with Rohit Karnik)
2020–	John Vergados, Chemical Engineering, MIT, <i>Ph.D.</i> (Co-advised with Fikile Brushett)
2020–	Pablo Dean, Chemical Engineering, MIT, <i>Ph.D.</i>
2020–	Eric Hahnert, Chemical Engineering, MIT, <i>Ph.D.</i>
2020–	Jing Ying Yeo, Chemical Engineering, MIT, <i>Ph.D.</i>
2019–	Aristotle Grosz, Chemical Engineering, MIT, <i>Ph.D.</i>
2019–	Wan-Ni Wu, Chemical Engineering, MIT, <i>Ph.D.</i>
2019–	Samuel Kaser, Chemistry, MIT, <i>Ph.D.</i>
2019–2023	Kayla Storme, Chemistry, MIT, <i>Ph.D.</i> (Co-advised with Tim Swager)
2018–	Taigyu Joo, Chemical Engineering, MIT, <i>Ph.D.</i>
2018–2023	Hyunhee Lee, Chemical Engineering, MIT, <i>Ph.D.</i>
2017–2022	Katherine Mizrahi Rodriguez, Materials Science and Engineering, MIT, <i>Ph.D.</i>
2017–2019	Patrick Asinger, Chemical Engineering, MIT, <i>M.S. CEP</i>
2016–2021	Sharon Lin, Chemical Engineering, MIT, <i>Ph.D.</i>
2016–2021	Qihui Qian, Chemical Engineering, MIT, <i>Ph.D.</i>
2016–2021	Albert Wu, Chemical Engineering, MIT, <i>Ph.D.</i>

Supervised Postdoctoral Associates/Fellows

2023–	Benjamin Pedretti, <i>Ph.D. in Chemical Engineering</i>
2022–	Taehoon Lee, <i>Ph.D. in Energy Engineering</i>
2022–	Matthew Rivera, <i>Ph.D. in Chemical & Biomolecular Engineering</i>

2021–2022	Maha Aljuhani, <i>Ph.D. in Chemical Science</i>
2020–2022	Stephen DeWitt, <i>Ph.D. in Chemical & Biomolecular Engineering</i>
2020–2021	Fatima Edhaim, <i>Ph.D. in Chemical Science</i>
2019–2021	Justin Teesdale, <i>Ph.D. in Chemistry</i>
2019–2021	Francesco Benedetti, <i>Ph.D. in Chemical Engineering</i>
2019–2021	Moonjoo Lee, <i>Ph.D. in Chemical Engineering</i>
2019–2020	Shaofei Wang, <i>Ph.D. in Chemical Engineering</i>
2018–2021	Gang (Andy) Han, <i>Ph.D. in Chemical Engineering</i>
2017–2019	Won Seok (Lucas) Chi, <i>Ph.D. in Chemical Engineering</i>

Visiting Researchers

2022	Anand Ayyar, University of Copenhagen, <i>Ph.D. Candidate in Chemistry</i>
2022	Mostafa Lotfy, ETH Zürich, <i>M.S. Candidate in Chemical Engineering</i>
2022	Tai Xuan Tan, Imperial College London, <i>M.S. in Chemical Engineering</i>
2020	Robin Studer, ETH Zürich, <i>M.S. Candidate in Chemical Engineering</i>
2018	Holden Lai, Stanford University, <i>Ph.D. Candidate in Chemistry</i>
2017–2018	Francesco Maria Benedetti, University of Bologna, <i>Ph.D. Candidate in Chemical Engineering</i>

Undergraduate Researchers

2023	Carlos Martinez, Chemical Engineering, MIT, <i>B.S.</i>
2022–	Gabrielle Moore, Chemical Engineering, MIT, <i>B.S.</i>
2022	Alondra Hernandez, Chemical Engineering, MIT, <i>B.S.</i>
2022	Iselle Barrios, Chemical Engineering, MIT, <i>B.S.</i>
2021–2023	Sherrie Qian, Materials Science and Engineering, MIT, <i>B.S.</i>
2021–2023	Ruoxin Lu, Chemical Engineering, MIT, <i>B.S.</i>
2021	Nicholas Aiello, Chemical Engineering, MIT, <i>B.S.</i>
2020–2023	Duha Syar, Chemical Engineering, MIT, <i>B.S.</i>
2020–2022	Naksha Roy, Chemical Engineering, MIT, <i>B.S.</i>
2020–2021	Nnedi Okoye, Chemical Engineering, MIT, <i>B.S.</i>
2020–2021	Evan Gwozdz, Chemical Engineering, MIT, <i>B.S.</i>
2019–2020	Laura Chen, Chemical Engineering, MIT, <i>B.S.</i>
2019–2020	Alexander Liu, Chemical Engineering, MIT, <i>B.S.</i>
2018–2019	James Drayton, Chemical Engineering, MIT, <i>B.S.</i>
2018–2019	Asia Hypsher, Chemical Engineering, MIT, <i>B.S.</i>
2018	Shiqi Zhao, Chemistry and Chemical Engineering, Tianjin University and Nankai University, <i>B.S.</i>

Department and Institute Service

2022–	First-year Academic Advisor
2019–2021	Chemical Engineering Seminar Coordinator
2019–	Chemical Engineering Undergraduate Advisor
2018–2019	MIT Committee on Toxic Chemicals
2018–2019	Chemical Engineering Representative for the Program in Polymers and Soft Matter (PPSM)
2018–2019	Chemical Engineering Undergraduate Curriculum Task Force, Chair for Separations (10.32)
2017–	MIT Faculty Member for PPSM
2017–	Chemical Engineering Graduate Admissions Committee

Professional Service

2024–	Associate Editor, <i>ACS Industrial & Engineering Chemistry Research</i>
2021–	Editorial Advisory Board for <i>Macromolecules</i>
2020–	Editorial Advisory Board for <i>Polymer</i>
2020–	Board of Directors, North American Membrane Society
2018–	Session Chair, North American Membrane Society National Meeting
2018–2019	Committee Member, National Academies of Sciences, Engineering, and Medicine Report on <i>A Research Agenda for Transforming Separation Science</i>
2017–	Session Chair, American Institute of Chemical Engineers National Meeting
2013–	Member, American Chemical Society
2010–	Member, American Institute of Chemical Engineers

Peer-Reviewed Publications

(*h-index 37, citations 6,449, Source Google Scholar*)

64. K. M. Rodriguez, S. Lin, A. X. Wu, K. R. Storme, T. Joo, A. F. Grosz, N. Roy, D. Syar, F. M. Benedetti, **Z. P. Smith***, Penetrant-induced plasticization in microporous polymer membranes (in press). *Chem. Soc. Rev.* (2024), doi:10.1039/d3cs00235g.
63. S. Guo, J. Y. Yeo, F. M. Benedetti, D. Syar, T. M. Swager, **Z. P. Smith***, A Microporous Poly(Arylene Ether) Platform for Membrane-Based Gas Separation (in press). *Angew. Chemie Int. Ed.* (2024), doi:10.1002/anie.202315611.
62. T. H. Lee, **Z. P. Smith***, Better standards are needed for membrane materials. *Nat. Mater.* 2024 231. 23, 11–12 (2024).
61. T. H. Lee, B. K. Lee, S. Y. Yoo, H. Lee, W. N. Wu, **Z. P. Smith**, H. B. Park, PolyMOF nanoparticles constructed from intrinsically microporous polymer ligand towards scalable composite membranes for CO₂ separation. *Nat. Commun.* 2023 141. 14, 1–13 (2023).
60. W. N. Wu, K. Mizrahi Rodriguez, N. Roy, J. J. Teesdale, G. Han, A. Liu, **Z. P. Smith***, Engineering the polymer–MOF interface in microporous composites to address complex mixture separations. *ACS Appl. Mater. Interfaces.* 15, 52893–52907 (2023).
59. R. J. Tannenbaum, N. Cislo, E. Ruzicka, P. A. Dean, **Z. P. Smith**, B. C. Benicewicz, S. K. Kumar, Activated gas transport in polymer-grafted nanoparticle membranes. *Macromolecules.* 56, 3954–3961 (2023).
58. T. Joo, K. Mizrahi Rodriguez, H. Lee, D. Acharya, C. M. Doherty, **Z. P. Smith***, The role of free volume, hydrogen bonds, and crosslinks on physical aging in polymers of intrinsic microporosity (PIMs). *J. Mater. Chem. A.* 11, 15943–15957 (2023).
57. S. Lin, K. R. Storme, Y.-C. M. Wu, F. M. Benedetti, T. M. Swager, **Z. P. Smith***, Role of side-chain length on gas transport of CO₂/CH₄ mixtures in polymers with side-chain porosity. *J. Membr. Sci.* 668, 121194 (2023).
56. G. Han, R. M. Studer, M. Lee, K. M. Rodriguez, J. J. Teesdale, **Z. P. Smith***, Post-synthetic modification of MOFs to enhance interfacial compatibility and selectivity of thin-film nanocomposite (TFN) membranes for water purification. *J. Membr. Sci.* 666, 121133 (2023).
55. J. J. Teesdale, M. Lee, R. Lu, **Z. P. Smith***, Uncertainty in composite membranes: From defect engineering to film processing. *J. Am. Chem. Soc.* 145, 830–840 (2023).
54. H. W. H. Lai, F. M. Benedetti, J. M. Ahn, A. M. Robinson, Y. Wang, I. Pinnau, **Z. P. Smith***, Y. Xia,

- Hydrocarbon ladder polymers with ultrahigh permselectivity for membrane gas separations. *Science*. 375, 1390–1392 (2022).
53. F. M. Benedetti, Y.-C. M. Wu, S. Lin, Y. He, E. Flear, K. R. Storme, C. Liu, Y. Zhao, T. M. Swager, **Z. P. Smith***, Side-chain length and dispersity in ROMP polymers with pore-generating side chains for gas separations. *JACS Au*. 2, 1610–1615 (2022).
 52. K. Mizrahi Rodriguez, W.-N. Wu, T. Alebrahim, Y. Cao, B. D. Freeman, D. Harrigan, M. Jhalaria, A. Kratochvil, S. Kumar, W. H. Lee, Y. M. Lee, H. Lin, J. M. Richardson, Q. Song, B. Sundell, R. Thür, I. Vankelecom, A. Wang, L. Wang, C. Wiscount, **Z. P. Smith***, Multi-lab study on the pure-gas permeation of commercial polysulfone (PSf) membranes: Measurement standards and best practices. *J. Membr. Sci.* 659, 120746 (2022).
 51. H. Lee, W. S. Chi, M. J. Lee, K. Zhang, F. Edhaim, K. Mizrahi Rodriguez, S. J. A. DeWitt, **Z. P. Smith***, Network-nanostructured ZIF-8 to enable percolation for enhanced gas transport. *Adv. Funct. Mater.* 32, 2207775 (2022).
 50. X. Qian, M. Ostwal, A. Asatekin, G. M. Geise, **Z. P. Smith***, W. A. Phillip, R. P. Lively, J. R. McCutcheon, A critical review and commentary on recent progress of additive manufacturing and its impact on membrane technology. *J. Membr. Sci.* 645, 120041 (2022).
 49. K. Mizrahi Rodriguez, F. M. Benedetti, N. Roy, A. X. Wu, **Z. P. Smith***, Sorption-enhanced mixed-gas transport in amine functionalized polymers of intrinsic microporosity (PIMs). *J. Mater. Chem. A*. 9, 23631–23642 (2021).
 48. Q. Qian, A. M. Wright, H. Lee, M. Dincă, **Z. P. Smith***, Low-temperature H₂S/CO₂/CH₄ separation in mixed-matrix membranes containing MFU-4. *Chem. Mater.* 33, 6825–6831 (2021).
 47. A. X. Wu, J. A. Drayton, X. Ren, K. Mizrahi Rodriguez, A. F. Grosz, J.-W. Lee, **Z. P. Smith***, Non-equilibrium lattice fluid modeling of gas sorption for fluorinated poly(ether imide)s. *Macromolecules*. 54, 6628–6638 (2021).
 46. A. X. Wu, S. Lin, K. Mizrahi Rodriguez, F. M. Benedetti, T. Joo, A. F. Grosz, K. R. Storme, N. Roy, D. Syar, **Z. P. Smith***, Revisiting group contribution theory for estimating fractional free volume of microporous polymer membranes. *J. Membr. Sci.* 636, 119526 (2021).
 45. A. X. Wu, J. A. Drayton, K. Mizrahi Rodriguez, F. M. Benedetti, Q. Qian, S. Lin, **Z. P. Smith***, Elucidating the role of fluorine content on gas sorption properties of fluorinated polyimides. *Macromolecules*. 54, 22–34 (2021).
 44. S. Lin, T. Joo, F. M. Benedetti, L. C. Chen, A. X. Wu, K. Mizrahi Rodriguez, Q. Qian, C. M. Doherty, **Z. P. Smith***, Free volume manipulation of a 6FDA-HAB polyimide using a solid-state protection/deprotection strategy. *Polymer*. 212, 123121 (2021).
 43. K. Mizrahi Rodriguez, S. Lin, A. X. Wu, G. Han, J. J. Teesdale, C. M. Doherty, **Z. P. Smith***, Leveraging free volume manipulation to improve the membrane separation performance of amine-functionalized PIM-1. *Angew. Chemie Int. Ed.* 60, 6593–6599 (2021).
 42. Q. Qian, P. A. Asinger, M. J. Lee, G. Han, K. Mizrahi Rodriguez, S. Lin, F. M. Benedetti, A. X. Wu, W. S. Chi, **Z. P. Smith***, MOF-based membranes for gas separations. *Chem. Rev.* 120, 8161–8266 (2020).
 41. A. X. Wu, J. A. Drayton, K. M. Rodriguez, Q. Qian, S. Lin, **Z. P. Smith***, Influence of aliphatic and aromatic fluorine groups on gas permeability and morphology of fluorinated polyimide films. *Macromolecules*. 53, 5085–5095 (2020).

40. C. R. Bilchak, M. Jhalaria, Y. Huang, Z. Abbas, J. Midya, F. M. Benedetti, D. Parisi, W. Egger, M. Dickmann, M. Minelli, F. Doghieri, A. Nikoubashman, C. J. Durning, D. Vlassopoulos, J. Jestin, **Z. P. Smith**, B. C. Benicewicz, M. Rubinstein, L. Leibler, S. K. Kumar, Tuning selectivities in gas separation membranes based on polymer-grafted nanoparticles. *ACS Nano*. 14, 17174–17183 (2020).
39. G. Han, K. M. Rodriguez, Q. Qian, **Z. P. Smith***, Acid-modulated synthesis of high surface area amine-functionalized MIL-101(Cr) nanoparticles for CO₂ separations. *Ind. Eng. Chem. Res.* 59, 18139–18150 (2020).
38. G. Han, Q. Qian, K. Mizrahi Rodriguez, **Z. P. Smith***, Hydrothermal synthesis of sub-20 nm amine-functionalized MIL-101(Cr) nanoparticles with high surface area and enhanced CO₂ uptake. *Ind. Eng. Chem. Res.* 59, 7888–7900 (2020).
37. K. Mizrahi Rodriguez, A. X. Wu, Q. Qian, G. Han, S. Lin, F. M. Benedetti, H. Lee, W. S. Chi, C. M. Doherty, **Z. P. Smith***, Facile and time-efficient carboxylic acid functionalization of PIM-1: Effect on molecular packing and gas separation performance. *Macromolecules*. 53, 6220–6234 (2020).
36. Q. Qian, W. S. Chi, G. Han, **Z. P. Smith***, Impact of post-synthetic modification routes on filler structure and performance in metal–organic framework-based mixed-matrix membranes. *Ind. Eng. Chem. Res.* 59, 5432–5438 (2020).
35. A. X. Wu, J. A. Drayton, **Z. P. Smith***, The perfluoropolymer upper bound. *AIChE J.* 65, e16700 (2019).
34. H. W. H. Lai, F. M. Benedetti, Z. Jin, Y. C. Teo, A. X. Wu, M. G. De Angelis, **Z. P. Smith***, Y. Xia, Tuning the molecular weights, chain packing, and gas-transport properties of CANAL ladder polymers by short alkyl substitutions. *Macromolecules*. 52, 6294–6302 (2019).
33. Q. Qian, A. X. Wu, W. S. Chi, P. A. Asinger, S. Lin, A. Hypsher, **Z. P. Smith***, Mixed-matrix membranes formed from imide-functionalized UiO-66-NH₂ for improved interfacial compatibility. *ACS Appl. Mater. Interfaces*. 11, 31257–31269 (2019).
32. W. S. Chi, B. J. Sundell, K. Zhang, D. J. Harrigan, S. C. Hayden, **Z. P. Smith***, Mixed-matrix membranes formed from multi-dimensional metal–organic frameworks for enhanced gas transport and plasticization resistance. *ChemSusChem*. 12, 2355–2360 (2019).
31. Y. He, F. M. Benedetti, S. Lin, C. Liu, Y. Zhao, H. Ye, T. Van Voorhis, M. G. De Angelis, T. M. Swager, **Z. P. Smith***, Polymers with side chain porosity for ultrapermeable and plasticization resistant materials for gas separations. *Adv. Mater.* 31, 1807871 (2019).
30. **Z. P. Smith**, J. E. Bachman, T. Li, B. Gludovatz, V. A. Kusuma, T. Xu, D. P. Hopkinson, R. O. Ritchie, J. R. Long, Increasing M₂(dobdc) loading in selective mixed-matrix membranes: A rubber toughening approach. *Chem. Mater.* 30, 1484–1495 (2018).
29. M. Shete, P. Kumar, J. E. Bachman, X. Ma, **Z. P. Smith**, W. Xu, K. A. Mkhoyan, J. R. Long, M. Tsapatsis, On the direct synthesis of Cu(BDC) MOF nanosheets and their performance in mixed matrix membranes. *J. Membr. Sci.* 549, 312–320 (2018).
28. C. Li, S. M. Meckler, **Z. P. Smith**, J. E. Bachman, L. Maserati, J. R. Long, B. A. Helms, Engineered transport in microporous materials and membranes for clean energy technologies. *Adv. Mater.* 30, 1704953 (2018).
27. M. Galizia, W. S. Chi, **Z. P. Smith**, T. C. Merkel, R. W. Baker, B. D. Freeman, 50th anniversary perspective: Polymers and mixed matrix membranes for gas and vapor separation: A review and prospective opportunities. *Macromolecules*. 50, 7809–7843 (2017).

26. K. A. Stevens, **Z. P. Smith**, K. L. Gleason, M. Galizia, D. R. Paul, B. D. Freeman, Influence of temperature on gas solubility in thermally rearranged (TR) polymers. *J. Membr. Sci.* 533, 75–83 (2017).
25. M. Galizia, K. A. Stevens, **Z. P. Smith**, D. R. Paul, B. D. Freeman, Nonequilibrium lattice fluid modeling of gas solubility in HAB-6FDA polyimide and its thermally rearranged analogues. *Macromolecules.* 49, 8768–8779 (2016).
24. J. E. Bachman, **Z. P. Smith**, T. Li, T. Xu, J. R. Long, Enhanced ethylene separation and plasticization resistance in polymer membranes incorporating metal–organic framework nanocrystals. *Nat. Mater.* 15, 845–849 (2016).
23. A. Kushwaha, M. E. Dose, **Z. P. Smith**, S. Luo, B. D. Freeman, R. Guo, Preparation and properties of polybenzoxazole-based gas separation membranes: A comparative study between thermal rearrangement (TR) of poly(hydroxyimide) and thermal cyclodehydration of poly(hydroxyamide). *Polymer.* 78, 81–93 (2015).
22. **Z. P. Smith**, G. Hernández, K. L. Gleason, A. Anand, C. M. Doherty, K. Konstas, C. Alvarez, A. J. Hill, A. E. Lozano, D. R. Paul, B. D. Freeman, Effect of polymer structure on gas transport properties of selected aromatic polyimides, polyamides and TR polymers. *J. Membr. Sci.* 493, 766–781 (2015).
21. R. R. Tiwari, **Z. P. Smith**, H. Lin, B. D. Freeman, D. R. Paul, Gas permeation in thin films of “high free-volume” glassy perfluoropolymers: Part II. CO₂ plasticization and sorption. *Polymer.* 61, 1–14 (2015).
20. N. C. Su, **Z. P. Smith**, B. D. Freeman, J. J. Urban, Size-dependent permeability deviations from Maxwells Model in hybrid cross-linked poly(ethylene glycol)/silica nanoparticle membranes. *Chem. Mater.* 27, 2421–2429 (2015).
19. K. L. Gleason, **Z. P. Smith**, Q. Liu, D. R. Paul, B. D. Freeman, Pure- and mixed-gas permeation of CO₂ and CH₄ in thermally rearranged polymers based on 3,3'-dihydroxy-4,4'-diamino-biphenyl (HAB) and 2,2'-bis-(3,4-dicarboxyphenyl) hexafluoropropane dianhydride (6FDA). *J. Membr. Sci.* 475, 204–214 (2015).
18. M. Galizia, **Z. P. Smith**, G. C. Sarti, B. D. Freeman, D. R. Paul, Predictive calculation of hydrogen and helium solubility in glassy and rubbery polymers. *J. Membr. Sci.* 475, 110–121 (2015).
17. **Z. P. Smith**, B. D. Freeman, Graphene oxide: A new platform for high-performance gas- and liquid-separation membranes. *Angew. Chemie Int. Ed.* 53, 10286–10288 (2014).
16. R. R. Tiwari, **Z. P. Smith**, H. Lin, B. D. Freeman, D. R. Paul, Gas permeation in thin films of “high free-volume” glassy perfluoropolymers: Part I. Physical aging. *Polymer.* 55, 5788–5800 (2014).
15. **Z. P. Smith**, K. Czenkusch, S. Wi, K. L. Gleason, G. Hernández, C. M. Doherty, K. Konstas, T. J. Bastow, C. Álvarez, A. J. Hill, A. E. Lozano, D. R. Paul, B. D. Freeman, Investigation of the chemical and morphological structure of thermally rearranged polymers. *Polymer.* 55, 6649–6657 (2014).
14. J. R. Wiegand, **Z. P. Smith**, Q. Liu, C. T. Patterson, B. D. Freeman, R. Guo, Synthesis and characterization of triptycene-based polyimides with tunable high fractional free volume for gas separation membranes. *J. Mater. Chem. A*, 2, 13309–13320 (2014).
13. **Z. P. Smith**, R. R. Tiwari, M. E. Dose, K. L. Gleason, T. M. Murphy, D. F. Sanders, G. Gunawan, L. M. Robeson, D. R. Paul, B. D. Freeman, Influence of diffusivity and sorption on helium and

- hydrogen separations in hydrocarbon, silicon, and fluorocarbon-based polymers. *Macromolecules*. 47, 3170–3184 (2014).
12. D. F. Sanders, R. Guo, **Z. P. Smith**, K. A. Stevens, Q. Liu, J. E. McGrath, D. R. Paul, B. D. Freeman, Influence of polyimide precursor synthesis route and ortho-position functional group on thermally rearranged (TR) polymer properties: Pure gas permeability and selectivity. *J. Membr. Sci.* 463, 73–81 (2014).
 11. D. F. Sanders, R. Guo, **Z. P. Smith**, Q. Liu, K. A. Stevens, J. E. McGrath, D. R. Paul, B. D. Freeman, Influence of polyimide precursor synthesis route and ortho-position functional group on thermally rearranged (TR) polymer properties: Conversion and free volume. *Polymer*. 55, 1636–1647 (2014).
 10. L. M. Robeson, **Z. P. Smith**, B. D. Freeman, D. R. Paul, Contributions of diffusion and solubility selectivity to the upper bound analysis for glassy gas separation membranes. *J. Membr. Sci.* 453, 71–83 (2014).
 9. D. F. Sanders, **Z. P. Smith**, R. Guo, L. M. Robeson, J. E. McGrath, D. R. Paul, B. D. Freeman, Energy-efficient polymeric gas separation membranes for a sustainable future: A review. *Polymer*. 54, 4729–4761 (2013).
 8. R. Guo, D. F. Sanders, **Z. P. Smith**, B. D. Freeman, D. R. Paul, J. E. McGrath, Synthesis and characterization of thermally rearranged (TR) polymers: Influence of ortho-positioned functional groups of polyimide precursors on TR process and gas transport properties. *J. Mater. Chem. A*, 1, 262–272 (2013).
 7. **Z. P. Smith**, R. R. Tiwari, T. M. Murphy, D. F. Sanders, K. L. Gleason, D. R. Paul, B. D. Freeman, Hydrogen sorption in polymers for membrane applications. *Polymer*. 54, 3026–3037 (2013).
 6. R. Guo, D. F. Sanders, **Z. P. Smith**, B. D. Freeman, D. R. Paul, J. E. McGrath, Synthesis and characterization of thermally rearranged (TR) polymers: Effect of glass transition temperature of aromatic poly(hydroxyimide) precursors on TR process and gas permeation properties. *J. Mater. Chem. A*, 1, 6063–6072 (2013).
 5. **Z. P. Smith**, D. F. Sanders, C. P. Ribeiro, R. Guo, B. D. Freeman, D. R. Paul, J. E. McGrath, S. Swinnea, Gas sorption and characterization of thermally rearranged polyimides based on 3,3'-dihydroxy-4,4'-diamino-biphenyl (HAB) and 2,2'-bis-(3,4-dicarboxyphenyl) hexafluoropropane dianhydride (6FDA). *J. Membr. Sci.* 415–416, 558–567 (2012).
 4. D. F. Sanders, **Z. P. Smith**, C. P. Ribeiro, R. Guo, J. E. McGrath, D. R. Paul, B. D. Freeman, Gas permeability, diffusivity, and free volume of thermally rearranged polymers based on 3,3'-dihydroxy-4,4'-diamino-biphenyl (HAB) and 2,2'-bis-(3,4-dicarboxyphenyl) hexafluoropropane dianhydride (6FDA). *J. Membr. Sci.* 409–410, 232–241 (2012).
 3. Y. Jiang, F. T. Willmore, D. Sanders, **Z. P. Smith**, C. P. Ribeiro, C. M. Doherty, A. Thornton, A. J. Hill, B. D. Freeman, I. C. Sanchez, Cavity size, sorption and transport characteristics of thermally rearranged (TR) polymers. *Polymer*. 52, 2244–2254 (2011).
 2. V. A. Kusuma, G. Gunawan, **Z. P. Smith**, B. D. Freeman, Gas permeability of cross-linked poly(ethylene-oxide) based on poly(ethylene glycol) dimethacrylate and a miscible siloxane comonomer. *Polymer*. 51, 5734–5743 (2010).
 1. G. L. Matters, J. F. Harms, C. O. McGovern, C. Jayakumar, K. Crepin, **Z. P. Smith**, M. C. Nelson, H. Stock, C. W. Fenn, J. Kaiser, M. Kester, J. P. Smith, Growth of human pancreatic cancer is

inhibited by down-regulation of gastrin gene expression. *Pancreas*. 38, e151 (2009).

Additional Publications

2. **Z. P. Smith**, *Fundamentals of gas sorption and transport in thermally rearranged polyimides*, Ph.D. Dissertation in Chemical Engineering. 2014, The University of Texas at Austin.
1. **Z. P. Smith**, *The fabrication of selective coal tar pitch membranes and their application in air separations*, B.S. Honors Thesis in Chemical Engineering. 2008, The Pennsylvania State University.

Invited Talks and Award Presentations

56. **Z. P. Smith**, “Opportunities and challenges for direct air capture of CH₄”, National Academies of Sciences, Engineering, and Medicine, Washington, D.C., Oct. 2023.
55. **Z. P. Smith**, P. Dean, F. M. Benedetti, S. Lin, A. X. Wu, K. Mizrahi Rodriguez, “Gas Separation Membranes for a Sustainable Future”, 3M Tech Forum, St. Paul, MN, Sept. 2023.
54. **Z. P. Smith**, P. Dean, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Designing microporous materials for membrane separations”, Department of Chemical Engineering Seminar, Penn State University, Aug. 2023.
53. **Z. P. Smith**, P. Dean, J. Y. Yeo, F. M. Benedetti, K. Mizrahi Rodriguez, J. J. Teesdale, “Engineering membrane materials for complex molecular separations”, Department of Chemical Engineering Seminar, University of Texas at Austin, April 2023.
52. **Z. P. Smith**, “Developing membrane materials for a sustainable future”, MIT Japan Conference, Tokyo, JP, Jan. 2023.
51. **Z. P. Smith**, P. Dean, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Membrane materials under complex conditions”, AIChE National Meeting, Phoenix, AZ, Nov. 2022. *Kunesh Award Presentation*.
50. **Z. P. Smith**, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, J. J. Teesdale, “Microporous materials for gas separations”, Department of Chemical Engineering Seminar, University of California, Berkeley, Oct. 2022.
49. **Z. P. Smith**, F. M. Benedetti, S. Lin, T. J. Joo, K. Mizrahi Rodriguez, “Designing polymers and MOFs for membrane-based gas separations”, Gordon Research Conference on Chemical Separations, Ventura, CA, Oct. 2022.
48. **Z. P. Smith**, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Leveraging microporous materials for gas separations”, Gordon Research Conference on Membranes: Materials and Processes, New London, NH, Aug. 2022.
47. **Z. P. Smith**, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Intrinsically porous polymers for gas separations”, Scheme for Promotion of Academic and Research Collaborations (SPARC) Conference (Virtual Visit), Bangalore, India, Jan. 2022.
46. **Z. P. Smith**, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Top-down and bottom-up strategies to engineer microporous materials for membrane-based gas separations”, Department of Chemical Engineering Seminar, KAUST (Virtual Visit), Thuwal, Saudi Arabia, Nov. 2021.
45. **Z. P. Smith**, “Upper bound theory and membranes for gas separations”, North American Membrane Society Webinar, Dec. 2020.
44. **Z. P. Smith**, F. M. Benedetti, S. Lin, K. Mizrahi Rodriguez, “Processable porous materials for membrane-based gas separations”, Network Young Membranes Plenary Lecture (Virtual Conference), Manchester, UK, Dec. 2020.
43. A. X. Wu, J. Drayton, **Z. P. Smith**, “The perfluoropolymer upper bound”, AIChE National Meeting (Virtual Conference), San Francisco, CA, Nov. 2020. *Futures: New Directions in Chemical Engineering Research Presentation*

40. **Z. P. Smith**, F. M. Benedetti, S. Lin, Q. Qian, "Engineering polymer microstructure and MOF-polymer interfaces for membrane-based separations", Soft Matter Seminar Series, Purdue University (Virtual Visit), Oct. **2020**.
41. **Z. P. Smith**, F. M. Benedetti, S. Lin, Q. Qian, "Designing polymers and MOFs for efficient and productive gas separations", Department of Chemical and Biological Engineering Seminar, University of Alabama (Virtual Visit), Sept. **2020**.
40. **Z. P. Smith**, F. M. Benedetti, S. Lin, Q. Qian, "Designing polymers for energy-efficient gas separation membranes", Student Polymer Collective, Stanford University (Virtual Visit), April **2020**.
39. **Z. P. Smith**, F. M. Benedetti, S. Lin, Q. Qian, "Designing polymers for molecular separations", Student Polymer Network Seminar, Georgia Tech, Oct. **2019**.
38. W. S. Chi, B. J. Sundell, K. Zhang, D. J. Harrigan, S. C. Hayden, **Z. P. Smith**, "Mixed-matrix membranes for natural gas purification", NanoTech 2019, Boston, MA, June **2019**.
37. F. M. Benedetti, Y. He, S. Lin, C. Liu, Y. Zhao, H. Ye, T. A. Van Voorhis, M. G. de Angelis, T. M. Swager, **Z. P. Smith**, "Solution-processable porous polymers for membrane-based separations", NanoTech 2019, Boston, MA, June **2019**.
36. Y. He, F. M. Benedetti, S. Lin, C. Liu, Y. Zhao, H. Ye, T. A. Van Voorhis, M. G. De Angelis, T. M. Swager, **Z. P. Smith**, "Membrane-based gas separations with a new class of ultrapermeable porous polymers", ACS National Meeting, Orlando, FL, April **2019**.
35. Q. Qian, **Z. P. Smith**, "Creating an ideal interface to form defect-free mixed-matrix membranes with UiO-66-NH₂", ACS National Meeting, Orlando, FL, March **2019**.
34. **Z. P. Smith**, F. M. Benedetti, S. Lin, T. M. Swager, T. A. Van Voorhis, Y. He, Q. Qian, A. Wu, W. S. Chi, P. Asinger, A. Hypsher, "Designing new materials for energy-efficient membrane separations", Department of Chemical Engineering Seminar, Auburn University, Jan. **2019**.
33. **Z. P. Smith**, F. M. Benedetti, S. Lin, T. M. Swager, T. A. Van Voorhis, Y. He, Q. Qian, A. Wu, W. S. Chi, P. Asinger, A. Hypsher, "Molecular design of materials for membrane-based separations", Polymer Program Seminar, University of Connecticut, Nov. **2018**.
32. **Z. P. Smith**, J. E. Bachman, T. Li, B. Gludovatz, V. Kusuma, T. Xu, D. P. Hopkinson, R. O. Ritchie, J. R. Long, "Evaluating an open metal site MOF for mixed-matrix membranes", ACS National Meeting, PMSE-NAMS Symposium, New Orleans, LA, March **2018**.
31. **Z. P. Smith**, "Polymers and metal-organic frameworks for energy-efficient separations", Department of Chemical Engineering Seminar, Tianjin University, Tianjin, CN, Jan. **2018**.
30. **Z. P. Smith**, "Hybrid polymer and MOF materials for membrane-based separations", Department of Materials Science Seminar, Tianjin Polytechnic University, Tianjin, CN, Jan. **2018**.
29. **Z. P. Smith**, "Membranes for energy-efficient separations", School of Physical Science and Technology Seminar, ShanghaiTech University, Shanghai, CN, Jan. **2018**.
28. **Z. P. Smith**, "From fundamentals to application: Taking Don Paul's guidance to develop new membrane materials", Department of Chemical Engineering Seminar, 50 Year Symposium and Celebration Honoring Don Paul, University of Texas at Austin, Sept. **2017**.
27. **Z. P. Smith**, "Polymers and MOFs for gas-phase separations", Department of Chemical Engineering Seminar, University of Queensland, Brisbane, AU, Sept. **2017**.
26. **Z. P. Smith**, "Molecular level design of polymers and MOFs for energy-efficient separations", Department of Chemical Engineering Seminar, University of New South Wales, Kensington, AU, Sept. **2017**.
25. **Z. P. Smith**, "Rational design of polymers and MOFs for membrane separations", Department of Chemistry Seminar, University of Sydney, Sydney, AU, Sept. **2017**.
24. **Z. P. Smith**, "Transport of small molecules in amorphous and crystalline membrane materials", Department of Chemistry Seminar, University of Adelaide, Adelaide, AU, Sept. **2017**.

23. **Z. P. Smith**, "Designing polymers and MOFs for small molecule diffusion and (ad)sorption selectivity", Department of Chemical Engineering Seminar, University of Melbourne, Melbourne, AU, Sept. 2017.
22. **Z. P. Smith**, "Molecular level design of polymers and MOFs for energy-efficient separations", Joint Seminar, Monash University and Commonwealth Industrial Research Organization (CSIRO), Clayton, AU, Sept. 2017.
21. **Z. P. Smith**, "Controlled transport in polymers and MOFs for molecular separations", Department of Chemistry Seminar, University of Copenhagen, Copenhagen, DK, Aug. 2017.
20. **Z. P. Smith**, J. E. Bachman, T. Li, B. Gludovatz, V. A. Kusuma, T. Xu, D. P. Hopkinson, R. O. Ritchie, J. R. Long, "Transport and mechanical properties of mixed-matrix membranes containing M₂(dobdc) nanoparticles", International Congress of Membranes, San Francisco, CA, July 2017. *Young Membrane Scientist Award Presentation.*
19. **Z. P. Smith**, J. E. Bachman, T. Li, T. Xu, B. Gludovatz, R. O. Ritchie, J. R. Long, "Gas transport and mechanical properties of mixed-matrix membranes formed with M₂(dobdc) nanoparticles", Gordon Research Conference on Membranes: Materials and Processes, New London, NH, Aug. 2016.
18. **Z. P. Smith**, "Polymer and mixed-matrix membranes for gas separations", Golden Gate Polymer Forum, Mountain View, CA, May 2016.
17. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical and Biological Engineering Seminar, University of Colorado, Boulder, March 2016.
16. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical and Biological Engineering Seminar, Rensselaer Polytechnic Institute, March 2016.
15. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering Seminar, Massachusetts Institute of Technology, Feb. 2016.
14. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering Seminar, Virginia Polytechnic Institute and State University, Feb. 2016.
13. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering Seminar, University of Florida, Feb. 2016.
12. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical and Biomolecular Engineering Seminar, University of Houston, Feb. 2016.
11. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering Seminar, Stanford University, Feb. 2016.
10. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering Seminar, Penn State University, Feb. 2016.
9. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical Engineering and Materials Science Seminar, University of Minnesota, Jan. 2016.
8. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical and Biomolecular Engineering Seminar, University of Illinois Urbana-Champaign, Jan. 2016.
7. **Z. P. Smith**, "Molecular scale engineering of new materials for energy-efficient separations" Department of Chemical and Biological Engineering Seminar, Northwestern University, Jan. 2016.

6. **Z. P. Smith**, J.E. Bachman, T. Li, T. Xu, J.R. Long, "Mixed-matrix membranes formed from $M_2(\text{dobdc})$ nanocrystals and polyimide-based copolymers", National Energy Technology Laboratory (NETL), Pittsburgh, PA, July 2015.
5. **Z. P. Smith**, G. Hernández, Á. E. Lozano, K. M. Czenkusch, D. F. Sanders, K. L. Gleason, R. Guo, J. E. McGrath, B. D. Freeman, D. R. Paul, "Gas sorption and transport in thermally rearranged polymers for membrane applications", Universidad de Valladolid, Valladolid, ES, July 2013.
4. **Z. P. Smith**, G. Hernández, Á. E. Lozano, K. M. Czenkusch, D. F. Sanders, K. L. Gleason, R. Guo, J. E. McGrath, B. D. Freeman, D. R. Paul, "Influence of chemical structure on gas sorption and transport in thermally rearranged polymers", Consejo Superior de Investigaciones Científicas (CSIC), Madrid, ES, July 2013.
3. **Z. P. Smith**, D. F. Sanders, B. D. Freeman, D. R. Paul, "Synthesis, characterization, and transport properties of thermally rearranged polyimides for gas separations", ACS National Meeting, New Orleans, LA, April 2013. *Excellence in Graduate Polymer Research Award Presentation.*
2. **Z. P. Smith**, "Fundamentals of gas transport in thermally rearranged polyimides", Commonwealth Scientific and Industrial Research Organization (CSIRO), Clayton, AU, July 2012.
1. **Z. P. Smith**, C. Tran, G. Gunawan, D. F. Sanders, C. P. Ribeiro Jr., B. D. Freeman, D. R. Paul, "Thermally rearranged ortho-functional polyimides for olefin/paraffin separations", Membrane Technology and Research, Inc., Menlo Park, CA, Aug. 2011.