W.S. Winston Ho

Distinguished Professor of Engineering
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Summary

- Expert in molecular and chemical separations including definition of approaches, design of practical systems, and scale-up and commercialization activities.
- Specialized in membranes and separations including polymer and liquid membranes, carbon dioxide capture, hydrogen purification, fuel cell fuel-processing and membranes, facilitated transport, supported liquid membranes, reverse osmosis, gas treating, and pervaporation.

Education

B.S., Chemical Engineering, National Taiwan University, Taipei, Taiwan, 1966.
M.S., Chemical Engineering, University of Illinois, Urbana-Champaign, Illinois, 1969.
Ph.D., Chemical Engineering, University of Illinois, Urbana-Champaign, Illinois, 1971.

Professional/Work Experiences

The Ohio State University, Columbus, OH, Distinguished Professor of Engineering, William G. Lowrie Department of Chemical and Biomolecular Engineering, Department of Materials Science and Engineering, Teaching and Research, 2002-present.

- Membrane application in CO_2 capture from flue gas in coal- and natural gas-fired power plants has been limited by the trade-off between CO_2 permeability and CO_2/N_2 selectivity of most polymeric membrane materials. To solve this problem, he was the first to invent, synthesize, and experimentally demonstrate novel amine-containing facilitated transport membranes (FTMs) capable of possessing both high CO_2 permeability and CO_2/N_2 selectivity. His group was the first to elucidate the unusual phenomenon of both permeability and selectivity increases with temperature. He and his students were the first to demonstrate and elucidate the effect of amine steric hindrance in the solid membrane, showing significant enhancement for CO_2 transport. Their further research on the synthesis of new mobile and fixed-site amine carriers with superior CO_2 sorption capacity has recently resulted in the unprecedent CO_2 permeance of 4200 GPU and CO_2/N_2 selectivity of >160, which are believed to be the best combined performance among those reported. They showed membrane modules stable to 1 – 3 ppm SO_2 and NOx in real flue gas at two successful field tests with 500-hour stable operation and achieved 90 – 99% CO_2 capture, all with >95% CO_2 purity, at the National Carbon Capture Center in Wilsonville, AL. The membrane is being demonstrated at 1 MWe engineering scale (20 tonne/day CO_2) using commercial-size 8″-diameter modules, each with 105 m^2, toward commercialization for flue gas CO_2 capture with support of ~$22 million from DOE, American Electric Power,

and Ohio. This is believed to offer the most cost-effective technology for CO_2 capture. Additional DOE fundings of about $14.5 million are for CO_2 capture from cement and natural gas power plants and for bio-syngas purification.

- Another important application of FTMs is the CO_2 capture from high pressure syngas. However, conventional FTMs are limited by the severe carrier saturation (CS) at high syngas pressure. His group has developed strategies to mitigate the CS. The membrane tailored for the proximity of feed inlet (13.8 bar CO_2 partial pressure) exhibited the superior performance with a CO_2 permeance of 300 GPU and a CO_2/H_2 selectivity of 107 whereas the membrane tailored for the proximity of retentate outlet (2.2 bar CO_2 partial pressure) showed a CO_2 permeance of 210 GPU with a CO_2/H_2 selectivity of 310 at ~110ºC. Spiral-wound membrane modules were fabricated and connected in the hybrid configuration, demonstrating a H_2 recovery of 99.3% from coal-derived syngas at 90% CO_2 removal and a CO_2 purity of 95.2%. They have also developed FTMs for H_2 purification for fuel cells at 1 – 2 atm. They removed H_2S to <10 ppb in the treated synthesis gas needed for water-gas-shift (WGS) reaction as H_2S deactivates commercially available WGS catalysts and the fuel cell Pt anode. They were also the first to obtain <10 ppm CO in the H_2 product with a WGS membrane reactor using the membrane to drive the WGS reaction to the product side via CO_2 removal. The data were in good agreement with their model prediction. This was the first CO_2-selective membrane reactor.
- Developed novel supported liquid membranes with strip dispersion for removal and recovery of indium from aqueous solutions and antibiotic (Cephalexin) from enzymatic synthesis mixtures. This work has resulted in effective recovery of indium for reuse in a commercial plant and effective Cephalexin recovery from enzymatic mixtures without enzyme deactivation, which commonly occurs when complexation is conducted in enzymatic reaction mixtures.
- Invented the novel concept of incorporating hydrophilic groups chemically into membrane structure to provide an additional pathway for water transport and to overcome the low hydrophilicity/flux issue inherent in interfacially polymerized membranes. This invention has resulted in >100% increase in water flux vs. the industry standard Film-Tec FT-30 membrane while maintaining a high NaCl rejection of >99%. Collaborating with an industrial partner, he has scaled up this membrane successfully to the commercial size of 42 inches wide for 2000 ft. The membrane testing by the Bureau of Reclamation has confirmed the superior performance. He and his co-workers have elucidated the membranes with increased hydrophilicity and reduced surface roughness for significantly decreasing fouling (by ~70%).
- Pioneered and developed the deposition of zeolite nanoparticles on nanoporous polymer support. This has improved the substrate with reduced interparticle pore size for decreasing membrane penetration and with increased hydrophilicity for providing good adhesion, resulting in improved membrane performance for CO_2 capture. This has also provided zeolite seeds for growing zeolite membranes on the polymer support, allowing for cost-effective roll-to-roll fabrication of zeolite membranes and inventions of zeolite / polymer composite membranes. The molecular sieve membranes have many applications including olefin/paraffin and isomer separations (e.g., xylenes).
- Developed new proton-exchange membranes (PEMs) synthesized from copolymers containing sulfonated hard segments for proton conductivity and hydrophilic soft segments for water retention. The PEMs have shown very high conductivity (0.1 S/cm at 0 – 50%

relative humidity, exceeding DOE's target), which is much higher than Nafion® at 120°C, and they have also exhibited effective conductivity at 25°C. The new membranes have also exhibited high fuel cell performance and can enable the widespread use of PEM fuel cells.
- Developed biocompatible and biodegradable poly(caprolactone) membranes with ~55 nm pores capable of a constant drug release rate for implantable drug delivery devices. This work has resulted in disappearance of cancer tumors in mice.

University of Kentucky, Lexington, KY, Professor of Chemical Engineering, Teaching and Research, 1999-2002.
- Effective transition from the industrial R&D of 28 years to academic teaching and research.
- Initiated research on a CO_2-selective water-gas-shift membrane reactor for hydrogen purification for fuel cells.

Commodore Separation Technologies, Inc., Kennesaw, GA, Senior Vice President, Technology, 1998-1999.
- Invented and developed novel supported liquid membranes (SLMs) with strip dispersion for removal and recovery of heavy metals (including chromium, copper, zinc, cobalt, nickel, mercury) and radionuclides (e.g., Sr-90) from waste waters and process streams. The strip dispersion provides the constant supply of organic membrane solution for solving the long-standing stability problem of SLMs and increases the surface area for stripping. The SLM technology is one of the most effective and very few zero-discharge processes for treating heavy metals and radionuclides in wastewaters.
- Invented and developed the novel SLM technology for toxic hexavalent chromium – it removes Cr(VI) down to less than 0.05 ppm and concentrates to ~20% Cr(VI) (~63% Na_2CrO_4) as a product, a zero discharge process.

Exxon Research and Engineering Company, Corporate Research, Annandale, NJ, Senior Scientist, 1977-1998.
- Jointly invented, developed, and commercialized 4 gas treating processes: (1) Flexsorb SE for selective H_2S removal from CO_2-containing gases, e.g., sulfur plant tail gas and natural gas, (2) Flexsorb SE Plus for low-leak, selective H_2S removal down to less than 10 ppm H_2S in the treated gas, (3) Flexsorb HP for CO_2 removal in H_2 and NH_3 plants, and (4) Flexsorb PS for simultaneous removal of H_2S and CO_2 from natural gas and synthesis gas; commercialized in more than 40 plants with a net present value of $500 million in 1985 dollar. The Flexsorb SE Plus solves the sulfur emission/acid rain problem from refineries and natural gas plants.
- Invented and developed the membrane process based on newly synthesized, novel polyimide-polyester segment copolymers for the separation of aromatic from saturated molecules via pervaporation, which was the first membrane technology for organic systems in the world. Elucidated the functions of hard and soft segments for high temperature molecular separations.
- Jointly developed new theoretical models for membrane separations, including solubility, diffusivity and transport models for pervaporation. These models have guided the molecular design of new copolymer membranes and given good prediction for aromatics/saturates separations.

- Invented and synthesized new separating agents, novel membranes and complexing solutions, for olefin/paraffin separations with high selectivity and flux / capacity. Jointly elucidated the carrier saturation phenomenon under high olefin pressures. This work has provided novel approaches for the separation of olefins, which are important petrochemical feedstocks.
- Invented and developed the synthesis of new separating agents including the new compositions of matter of sterically hindered amines for gas treating and polyimide-polyester copolymers for aromatics/saturates separations.
- Developed the new advancing front model for emulsion liquid membranes (ELMs) and the fluid dynamic model for core-annular flow. The advancing front model provided the first quantitative description of ELMs without adjustable parameters. The fluid dynamic model gives a quantitative description of core-annular flow.
- Developed novel fluids for fracturing and controlling oil and gas wells.
- Developed membrane processes for pollution control, organics removal, and hydrometallurgical extraction.
- Held various supervisory and team leadership positions (for 12 years) including section/group head and project leader.

Xerox Corporation, Wilson Center for Technology, Webster, NY, Scientist, 1974-1977.

- Developed film coating processes for commercialization of new organic photoreceptors; investigated the processes theoretically and experimentally for scale-up and commercialization.
- Elucidated the diffusion of solvents in polymeric films for drying of organic coatings; investigated the dispersion of inorganic pigments into binder, solvent, and coating systems.

Allied Chemical Corporation, Central Research Laboratories, Morristown, NJ, Research Engineer, 1971-1974.

- Invented and developed the novel concept of using a membrane as the interface stabilizer for the membrane solvent extraction process to eliminate dispersing, entrainment, back mixing, and flooding problems and to overcome density difference and mass transfer limitations. This concept has been used for membrane contactors and led to their commercialization for carbonization of beverages, stripping of oxygen from water for boilers and metal vessels to prevent them from corrosion, and blood oxygenation for lung disease patients.
- Developed new polymeric membranes and membrane solvent extraction processes for wastewater treatment, organics removal, and hydrometallurgical extraction.

Awards and Honors

1. Professional Societies and Academies

- Member, the National Academy of Engineering, U.S.A., 2002.
- Academician, Academia Sinica, Taiwan, 2014.
- Chairman, AIChE Separations Division, 1997 (elected in 1994 for Second Vice-Chairman in 1995 and First Vice-Chairman in 1996).
- Director, AIChE Separations Division, 1992-1993.

- Meeting Program Chairman (invited), AIChE Spring National Meeting in Atlanta, GA, March 5-9, 2000 – set record numbers of attendees, topical conferences and technical sessions in the AIChE Spring National Meeting history so far, up to this meeting.
- Chairman, Board of Directors, Chinese-American Chemical Society (CACS), 2002-2008.
- Meeting Program Chairman (invited), AIChE Annual Meeting in Nashville, TN, November 8-13, 2009 – a great success with excellent program and attendance in spite of the tough economic situation.
- Director of Board, North American Membrane Society, 2005-2011.
- Fellow, American Institute of Chemical Engineers, 2009-now.
- Chair, AIChE Executive Board of Program Committee, 2015, Immediate Past Chair, 2016, First Vice Chair, 2014, and Second Vice Chair, 2013.

2. Awards

- Institute Award for Excellence in Industrial Gases Technology, American Institute of Chemical Engineers, 2006.
- Clarence G. Gerhold Award, Separations Division of the American Institute of Chemical Engineers, 2007.
- Co-winner of Graduate Research Paper Award in Separations, Separations Division of the American Institute of Chemical Engineers, 2007.
- Industrial Research 100 Award for Flexsorb SE gas treating research and development, 1985.
- Honorable Mention of the Kirkpatrick Chemical Engineering Achievement Award for Flexsorb SE, 1985.
- Inventor of the Year, New Jersey Inventors Congress and Hall of Fame, 1991.
- Co-editor of Membrane Handbook, Recipient of the Professional and Scholarly Publishing Award for the most outstanding engineering work, 1993.
- American Institute of Chemical Engineers' Excellence and Appreciation Award, 2000.
- Chemcon Distinguished Speaker Award, Indian Institute of Chemical Engineers, 2004.
- Innovators Award, College of Engineering, The Ohio State University, 2008.
- First Place Graduate Research Poster Paper Award, the Annual Meeting of North American Membrane Society, Charleston, SC, June 21-24, 2009.
- American Institute of Chemical Engineers' Excellence and Appreciation Award, 2009.
- Lumley Research Award, College of Engineering, The Ohio State University, 2010.
- Advisor Recognition for Graduate Research Paper Award in Separations, Separations Division of the American Institute of Chemical Engineers, 2011.
- Lawrence B. Evans Award in Chemical Engineering Practice, American Institute of Chemical Engineers, 2012.
- Distinguished Alumnus Award and Keynote Speech, Centennial Celebration of Wan-Li Elementary School, Wan-Li, New Taipei City, Taiwan, March 31, 2013.
- Distinguished Alumnus Award, the 70th Anniversary of the Department of Chemical Engineering, National Taiwan University, Taipei, Taiwan, 2015.
- Chemcon Distinguished Speaker Award – Prof. G. S. Laddha Medal, Indian Institute of Chemical Engineers, 2015.

- IMR Innovation Award for Most Invention Disclosures Filed, Institute for Materials Research (IMR), The Ohio State University, 2017.
- Accelerator Award, Office of Technology Commercialization, The Ohio State University, 2017.
- Leadership Award for Innovations in Green Process Engineering, Program Committee, American Institute of Chemical Engineers, 2018.
- Outstanding Alumnus Award, National Taiwan University, Taipei, Taiwan, 2020.

3. Other Honors

- Honorary International Chair Professor, Tianjin Polytechnic University, Tianjin, China, 2017-now.
- Invited Visiting Professor, Beijing University of Chemical Technology, Beijing, China, 2017-now.
- Honorary Professor, Tianjin University, Tianjin, China, 2015-now.
- Invited Guest Distinguished Chair Professor, Department of Chemical Engineering, National Taiwan University, Taipei, Taiwan, 2010-now.
- Invited Guest Chair Professor of Membranes, R&D Center for Membrane Technology, Chung Yuan University, Chung-Li, Taiwan, 2005-2018.
- Invited University Advisor, Chung Yuan University, Chung-Li, Taiwan, 2005-2018.
- Invited Member, Advanced R&D Advisory Committee, Industrial Technology Research Institute, Hsinchu, Taiwan, 2007-2009.
- Invited Shell Chair Professor, Tsinghua University, Beijing, China, 2006, 2008.
- Invited Guest Professor, Zhejiang University, Hangzhou, Zhejiang, China, 2007-2018.
- Invited Member, National Research Council panel on carbon sequestration, 2004-2005.
- Invited Member, National Research Council panel on alternative liquid transportation fuels, 2007-2009.
- Invited Commencement Speaker, Department of Chemical Engineering, National Taiwan University, Taipei, Taiwan, June 5, 2010.
- Invited Distinguished Lecturer, "New Membranes for CO_2 Separation and H_2 and Water Purification", Waterloo Institute for Nanotechnology at the University of Waterloo, Waterloo, Ontario, Canada, April 14, 2011.
- Invited John A. Quinn Lecturer in Chemical Engineering, "Facilitated Transport Membranes for CO_2 and Antibiotic Separations", Department of Chemical and Biomolecular Engineering, University of Pennsylvania, Philadelphia, PA, April 25, 2012.
- Invited Member, National Research Council panel on energy and water, 2013.
- Invited Lecturer, Bent Seminar, "New Developments on Membranes for CO_2 and Water Separations", Department of Chemical Engineering, University of Missouri, Columbia, MO, March 18, 2014.
- Three Sessions in Honor of Winston Ho at the Annual Meeting of the American Institute of Chemical Engineers in Atlanta, GA, November 16-21, 2014.
- Invited Honorary Chief Science Advisor, Center for Membrane and Water Science and Technology, Zhejiang University of Technology, Hangzhou, Zhejiang, China, 2016-now.
- Honorary Faculty, Indian Institute of Technology Guwahati, Guwahati, India, 2020-now.

Memberships

American Chemical Society (ACS)
American Institute of Chemical Engineers (AIChE)
Chinese-American Chemical Society (CACS)
North American Membrane Society (NAMS)
Phi Lambda Upsilon (Honorary Chemical Society)
AIChE Separations Division

Personal Data

Married: wife Annie; four married children: Alexander, Anthony, Christina and Monica.

Publications

• Books Edited

1. W. S. W. Ho and K. K. Sirkar, eds., Membrane Handbook, Chapman & Hall, New York (1992), Kluwer Academic Publishers, Boston, reprint edition (2001), Springer US, New York, reprint edition (2012).
2. N. N. Li, E. Drioli, W. S. W. Ho, and G. G. Lipscomb, eds., Advanced Membrane Technology, New York Academy of Sciences, New York (2003).
3. N. N. Li, A. G. Fane, W. S. W. Ho, and T. Matsuura, eds., Advanced Membrane Technology and Applications, John Wiley & Sons, New York (2008).

• Book

4. M. P. Ramage, G. D. Tilman, D. Gray, R. D. Hall, E. A. Hiler, W. S. W. Ho, D. L. Karlen, J. R. Katzer, M. R. Ladisch, J. A. Miranowski, M. Oppenheimer, R. F. Probstein, H. H. Schobert, C. R. Somerville, G. Stephanopoulos, and J. L. Sweeney, Liquid Transportation Fuels from Coal and Biomass, The National Academies Press, Washington (2009).

• Papers and Book Chapters

5. J. A. Quinn, J. L. Anderson, W. S. W. Ho, and W. J. Petzny, "Model Pores of Molecular Dimension: The Preparation and Characterization of Track-Etched Membranes", Biophys. J., 12, 990-1007 (1972).
6. W. S. W. Ho and F. A. Holland, "Between-Rolls Metering Coating Technique: A Theoretical and Experimental Study", TAPPI, 61, 53-56 (1978).
7. W. S. W. Ho, T. A. Hatton, E. N. Lightfoot, and N. N. Li, "Extraction with Liquid Surfactant Membranes: A Diffusion Controlled Model", Proceedings of the Second World Congress of Chemical Engineering, Montreal, Canada, Volume IV, pp. 209-215 (1981).
8. R. E. Terry, N. N. Li, and W. S. W. Ho, "Extraction of Phenolic Compounds and Organic Acids by Liquid Membranes", J. Membr. Sci., 10, 305-323 (1982).
9. W. S. W. Ho, T. A. Hatton, E. N. Lightfoot, and N. N. Li, "Batch Extraction with Liquid Surfactant Membranes: A Diffusion Controlled Model", AIChE J., 28, 662-670 (1982).

10. J. Bock, R. R. Klein, P. L. Valint, and W. S. W. Ho, "Liquid Membrane Extraction of Uranium from Wet Process Phosphoric Acid", in Sulfuric/Phosphoric Acid Plant Operations, American Institute of Chemical Engineers, New York, pp. 175-183 (1982).
11. H. C. Hayworth, W. S. W. Ho, W. A. Burns, and N. N. Li, "Extraction of Uranium from Wet Process Phosphoric Acid by Liquid Membranes", Separ. Sci. Technol., 18, 493-521 (1983).
12. W. S. W. Ho and N. N. Li, "Modeling of Liquid-Membrane Extraction Processes", in Hydrometallurgical Process Fundamentals, R. G. Bautista, ed., Plenum Press, New York, pp. 555-597 (1984). (invited).
13. W. S. W. Ho and N. N. Li, "Membrane Processes", in Perry's Chemical Engineers' Handbook, R. H. Perry and D. Green, eds., McGraw-Hill Book Co., New York, 6th Edition, Section 17, pp. 14-35 (1984). (invited).
14. M. E. Edgerton, G. D. Byrne, and W. S. W. Ho, "Numerical Calculation of the Simultaneous Absorption of Two Gases with Reversible Chemical Reactions", Comput. Chem. Eng., 10, 551-556 (1986).
15. D. W. Savage, G. R. Chludzinski, S. Wiechert, J. L. Kaufman, L. L. Ansell, W. S. W. Ho, and G. Sartori, "New Absorption Processes for Selective Hydrogen Sulfide Separation and Other Gas Treating Applications", Inst. Chem. Eng. Symp. Ser., 104, A347-A358 (1987).
16. G. Sartori, W. S. W. Ho, D. W. Savage, G. R. Chludzinski, and S. Wiechert, "Sterically-Hindered Amines for Acid Gas Absorption", Separ. Purif. Methods, 16, 171-200 (1987).
17. W. S. W. Ho, G. Doyle, D. W. Savage, and R. L. Pruett, "Olefin Separations via Complexation and Transport with Cuprous Diketonate", Proceedings of the 1987 International Congress on Membranes and Membrane Processes, Tokyo, Japan, pp. 783-784 (1987).
18. G. T. Rochelle, P. C. Tseng, W. S. W. Ho, and D. W. Savage, "H_2S Vapor-Liquid Equilibrium Measurement by the Electrode Method", Ind. Eng. Chem. Res., 27, 195-197 (1988).
19. P. C. Tseng, W. S. W. Ho, and D. W. Savage, "Carbon Dioxide Absorption into Promoted Carbonate Solutions", AIChE J., 34, 922-931 (1988).
20. W. S. W. Ho, G. Doyle, D. W. Savage, and R. L. Pruett, "Olefin Separations via Complexation with Cuprous Diketonate", Ind. Eng. Chem. Res., 27, 334-337 (1988).
21. W. S. W. Ho, "Emulsion Liquid Membranes: A Review", Proceedings of the 1990 International Congress on Membranes and Membrane Processes, Chicago, IL, Vol. I, pp. 692-694 (1990).
22. S. J. Doong and W. S. W. Ho, "Sorption of Organic Vapors in Semicrystalline Polyethylene", Polymer Preprints, 31 (2), 580 (1990).
23. S. J. Doong and W. S. W. Ho, "Sorption of Organic Vapors in Polyethylene", Ind. Eng. Chem. Res., 30, 1351-1361 (1991).
24. S. J. Doong and W. S. W. Ho, "Diffusion of Hydrocarbons in Polyethylene", Ind. Eng. Chem. Res., 31, 1050-1060 (1992).
25. W. S. W. Ho and N. N. Li, "Recent Advances in Emulsion Liquid Membranes", Proceedings of the First AIChE Separations Division Topical Conference on Separations Technologies: New Developments and Opportunities, Miami Beach, FL, pp. 762-767 (1992).

26. W. S. W. Ho and K. K. Sirkar, "The State of the Art of Membrane Processes: An Overview", Ibid., pp. 782-787 (1992).
27. S. J. Doong and W. S. W. Ho, "Sorption and Diffusion of Aromatic Hydrocarbons in Semicrystalline Polyethylene", Proceedings of the Fifth Annual Meeting of the North American Membrane Society, Lexington, KY, Paper 4E (1992).
28. W. S. W. Ho and K. K. Sirkar, "Overview of Membrane Processes", in Membrane Handbook, W. S. W. Ho and K. K. Sirkar, eds., Chapman & Hall, New York, pp. 1-15 (1992).
29. W. S. W. Ho and N. N. Li, "Definitions for Emulsion Liquid Membranes", Ibid., pp. 597-610 (1992).
30. W. S. W. Ho and N. N. Li, "Theory for Emulsion Liquid Membranes", Ibid., pp. 611-655 (1992).
31. Z. M. Gu, W. S. W. Ho, and N. N. Li, "Design Considerations for Emulsion Liquid Membranes", Ibid., pp. 656-700 (1992).
32. W. S. W. Ho and D. C. Dalrymple, "Facilitated Transport of Olefins in Ag^{+}-Containing Polymer Membranes", J. Membr. Sci., 91, 13-25 (1994).
33. W. S. W. Ho and N. N. Li, "Core-Annular Flow of Liquid Membrane Emulsion", AIChE J., 40, 1961-1968 (1994).
34. G. Sartori, W. S. W. Ho, W. A. Thaler, G. R. Chludzinski, and J. C. Wilbur, "Sterically-hindered Amines for Acid Gas Absorption", Spec. Publ.-R. Soc. Chem., 153, 205 (1994).
35. S. J. Doong, W. S. W. Ho, and R. P. Mastondrea, "Prediction of Flux and Selectivity in Pervaporation through a Membrane", J. Membr. Sci., 107, 129-146 (1995).
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37. J. D. Way and W. S. W. Ho, "A Tribute to Norman N. Li", in Chemical Separations with Liquid Membranes, R. A. Bartsch and J. D. Way, eds., American Chemical Society, Washington, DC, ACS Symposium Series, 642, 11-15 (1996).
38. W. S. W. Ho and N. N. Li, "Recent Advances in Emulsion Liquid Membranes", in Chemical Separations with Liquid Membranes, R. A. Bartsch and J. D. Way, eds., American Chemical Society, Washington, DC, ACS Symposium Series, 642, 208-221 (1996).
39. J. Zhou, W. S. W. Ho, and N. N. Li, "Separation Processes", in Encyclopedia of Applied Physics, G. L. Trigg, ed., VCH Publishers, Brooklyn, NY, pp. 599-641 (1996).
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41. D. W. Zhou, C. R. Huang, N. N. Li, and W. S. W. Ho, "Removal of Strontium from Wastewater by Emulsion Liquid Membrane", Ibid., Paper S-8-1-5 (1996).
42. W. S. W. Ho, G. Sartori, W. A. Thaler, D. C. Dalrymple, R. P. Mastondrea, and D. W. Savage, "Thin Membranes of New Hard/Soft Segment Copolymers", Proceedings of the First Joint Topical Conference on Processing: Structure and Properties of Polymeric Materials at AIChE Annual Meeting, Chicago, IL, pp. 135-137 (1996).

43. W. S. W. Ho and N. N. Li, "Recent Advances in Emulsion Liquid Membranes", Proceedings of the Second Joint China/USA Chemical Engineering Conference, Beijing, China, pp. 578-584 (1997).
44. W. S. W. Ho and G. Sartori, "Advances in Gas Treating and Membrane Separation", Ibid., pp. 593-598 (1997).
45. W. S. W. Ho and R. G. Luo, eds., Proceedings of the Topical Conference on Separation Science and Technologies at AIChE Annual Meeting, Los Angeles, CA (1997).
46. W. S. W. Ho, G. Sartori, H. L. Fang, W. A. Thaler, D. C. Dalrymple, and R. P. Mastondrea, "Crosslinked Polyimide-Polyester Copolymer Membranes for Aromatics/Saturates Separation", Proceedings of the Topical Conference on Separation Science and Technologies at AIChE Annual Meeting, Los Angeles, CA, pp. 745-750 (1997).
47. G. Sartori, H. W. Deckman, W. S. W. Ho, J. R. Livingston, E. J. Mozeleski, "Membrane-Confined Rh Catalyst for Oxo Reaction", Ibid., pp. 665-667 (1997).
48. G. Sartori, W. S. W. Ho, R. E. Noone, and B. H. Ballinger, "Poly(fluoroolefin) Membranes for Aromatics/Saturates Separation", Ibid., pp. 1403-1407 (1997).
49. W. S. W. Ho, T. K. Poddar, R. Pusic, and J. Roller, "Unique Membrane Technology for Removal/Recovery of Metals from Wastewaters and Process Streams", Proceedings of the American Electroplaters and Surface Finishers Society/EPA Conference, Lake Buena Vista, FL, Jan. 25–27, 1999, pp. 141-148.
50. W. S. W. Ho, T. K. Poddar, R. Pusic, and J. Roller, "Supported Liquid Membrane Process for Chromium Removal and Recovery", Proceedings of the 1999 International Congress on Membranes and Membrane Processes, Toronto, Canada, June 12–18, 1999.
51. R. Song, W. S. W. Ho, N. N. Li, and R. J. Petersen, "Polyamide TFC Membrane Formation Studies", Ibid., (1999).
52. W. S. W. Ho, T. K. Poddar, and J. Roller, "New Membrane Technology for Chromium Removal and Recovery", Proceedings of the 4th Topical Conference on Separation Science and Technologies at AIChE Annual Meeting, Dallas, TX, Paper 12e (1999).
53. W. S. W. Ho, B. Wang, T. E. Neumuller, and J. Roller, "Supported Liquid Membranes for Removal and Recovery of Metals from Waste Waters and Process Streams", Ibid., Paper 200d (1999).
54. W. S. W. Ho, S. Kalini, and T. K. Poddar, "Cobalt Removal and Recovery with Supported Liquid Membranes", Proceedings of the Topical Conference on Membrane and Extraction Science and Technologies for Environmental Applications at AIChE Spring National Meeting, Atlanta, GA, pp. 10-15 (2000).
55. W. S. W. Ho and T. K. Poddar, "New Membrane Technology for Removal and Recovery of Metals from Waste Waters and Process Streams", Ibid., pp. 38-43 (2000).
56. M. A. Kuehne, R. Q. Song, N. N. Li, W. S. W. Ho, and R. J. Petersen, "Flux Enhancement in TFC RO Membranes", Proceedings of the Third Joint China/USA Chemical Engineering Conference, Beijing, China, pp. 04-041 – 04-044 (2000).
57. W. S. W. Ho and T. K. Poddar, "New Membrane Technology for Removal and Recovery of Metals from Waste Waters", Ibid., pp. 04-120 – 04-128 (2000).
58. W. S. W. Ho and T. K. Poddar, "New Membrane Technology for Removal and Recovery of Chromium from Waste Waters", Environ. Prog., 20, 44-52 (2001).

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179. W. S. W. Ho and Y. Han, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. OER-CDO-D-19-12, Quarterly Progress Report for January 1, 2022 – March 31, 2022, Ohio Office of Energy Report, Ohio Department of Development, Columbus, OH, April 30, 2022.
180. W. S. W. Ho and Y. Han, "Transformational Membranes for Pre-Combustion Carbon Capture", Project No. DE-FE0031635, Final Project Report, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, June 11, 2022.
181. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for April 1, 2022–June 30, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, July 24, 2022.
182. Y. Han and W. S. W. Ho, "Moving beyond 90% Carbon Capture by Highly Selective Membrane Processes", Membranes, 12, 4, 399 (2022), doi:10.3390/membranes12040399, Project No. DE-FE0031731, Office of Scientific and Technical Information Report, OSTI ID: 1877553, U.S. Department of Energy, Washington, DC, July 24, 2022.
183. R. Pang, Y. Yang, Y. Han, K. K. Chen, and W. S. W. Ho, "Bicontinuous Substrates with Reduced Pore Restriction for CO_2-Selective Composite Membranes", Journal of Membrane Science, 654, 120547 (2022), doi:10.1016/j.memsci.2022.120547, Project No. DE-FE0031731, Office of Scientific and Technical Information Report, OSTI ID: 1877554, U.S. Department of Energy, Washington, DC, July 24, 2022.
184. X. Deng, Y. Han, L.-C. Lin, and W. S. W. Ho, "A New Measurement of Amine Steric Hindrance – N Exposure", Separation and Purification Technology, 299, 121601 (2022), doi:10.1016/j.seppur.2022.121601, Project No. DE-FE0031731, Office of Scientific and Technical Information Report, OSTI ID: 1877555, U.S. Department of Energy, Washington, DC, July 24, 2022.
185. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Quarterly Progress Report for April 1, 2022 – June 30, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, July 25, 2022.
186. W. S. W. Ho and Y. Han, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. OER-CDO-D-19-12, Quarterly Progress Report for April 1, 2022 – June 30, 2022, Ohio Office of Energy Report, Ohio Department of Development, Columbus, OH, July 30, 2022.

187. W. S. W. Ho and Y. Han, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. OER-CDO-D-19-12, Project Final Report for January 1, 2020 – June 30, 2022, Ohio Office of Energy Report, Ohio Department of Development, Columbus, OH, July 30, 2022.
188. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for July 1, 2022 – September 30, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, October 21, 2022.
189. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Quarterly Progress Report for July 1, 2022 – September 30, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, October 28, 2022.
190. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for October 1, 2022 – December 31, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, January 25, 2023.
191. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Quarterly Progress Report for October 1, 2022 – December 31, 2022, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, January 27, 2023.
192. T.-Y. Chen, X. Deng, L.-C. Lin, and W. S. W. Ho, "^{13}C NMR Study of Amino Acid Salts in Facilitated Transport Membranes for Post-Combustion Carbon Capture", J. Membr. Sci., doi:10.1016/j.memsci.2022.121309 online (12/24/2022), 671, 121309 (1/26/2023), Project No. DE-FE0031731, Office of Scientific and Technical Information Report, OSTI ID: 1922219, U.S. Department of Energy, Washington, DC, January 27, 2023.
193. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Quarterly Progress Report for January 1, 2023 – March 31, 2023, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, April 15, 2023.
194. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for January 1, 2023 – March 31, 2023, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, April 26, 2023.
195. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Final Project Technical Report for July 1, 2019 – March 31, 2023, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, June 20, 2023.
196. W. S. W. Ho, Yang Han, and Li-Chiang Lin, "Transformational Membranes and Process for CO_2 Capture from Flue Gas", Project No. DE-FE0031731, Final Project Technical

Report for July 1, 2019 – March 31, 2023, Office of Scientific and Technical Information Report, OSTI ID: 1985659, U.S. Department of Energy, Washington, DC, June 20, 2023.

197. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for April 1, 2023 – June 30, 2023, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, July 29, 2023.
198. S. Li, Y. Han and W. S. W. Ho, "Engineering Scale Design and Testing of Transformational Membrane Technology for CO_2 Capture", Project No. DE-FE0031946, Quarterly Progress Report for July 1, 2023 – September 30, 2023, National Energy Technology Laboratory Report, U.S. Department of Energy, National Energy Technologies Laboratory, Pittsburgh, PA, October 24, 2023.

Plenary and Keynote Lectures

1. Keynote Lecture, "Hard/Soft Segment Copolymer Membranes for Aromatics / Saturates Separation", 1996 International Congress on Membranes and Membrane Processes, Yokohama, Japan, Paper No. S-20-1-K, August 18-23, 1996.
2. Invited Plenary Lecture, "Recent Developments and Applications for Hollow-Fiber Membranes", Textile International Forum and Exhibition 2001, Taipei, Taiwan, November 14-16, 2001.
3. Invited Plenary Lecture, "Facilitated Transport Membranes for Environmental and Energy Applications", the International Symposium on Emerging Environmental Technology, Gwangju Institute of Science and Technology, Gwangju, Korea, Nov. 4, 2003.
4. Invited Plenary Lecture, "Recent Developments on Membranes for Water Purification", 10th International Workshop on Drinking Water Quality Management and Treatment Technology, Taipei, Taiwan, Paper No. B4-1, June 1-2, 2004.
5. Keynote Lecture, "Carbon Dioxide-Selective Water-Gas-Shift Membrane Reactor: A Modeling Study for Fuel Cells", North American Membrane Society 2004 Annual Meeting, Honolulu, Hawaii, June 26-30, 2004.
6. Invited Keynote Lecture, "Engineering Membranes for Environmental and Energy Applications", 10th Congress of Asia Pacific Confederation of Chemical Engineering, Kitakyushu, Japan, Paper No. 3F-01, October 17-21, 2004.
7. Invited Keynote Lecture, "Facilitated Transport Membranes for Environmental and Energy Applications", First India-USA Joint Chemical Engineering Conference, Mumbai, India, Paper No. 12.6.2, December 28-30, 2004.
8. Invited Keynote Lecture, "A Modeling and Experimental Study of Novel CO_2-Selective Membrane Reactor with Water Gas Shift Reaction for Fuel Cells", 2005 International Membrane Conference, Chung-Li, Taiwan, Paper No. PL-III, August 18-19, 2005.
9. Invited Keynote Lecture, "CO_2-Selective Water-Gas-Shift Membrane Reactor for Fuel Cells: A Modeling and Experimental Study", 2005 International Congress on Membranes and Membrane Processes, Seoul, Korea, Paper No. Mo02D-1, August 21-26, 2005.
10. Invited Keynote Lecture, "Facilitated Transport Membranes: New Directions for Environmental, Bio and Energy Applications", China/USA/Japan Joint Chemical Engineering Conference, Beijing, China, Paper No. SE10E-1, October 11-13, 2005.

11. Invited Keynote Lecture, "Facilitated Transport Membranes: New Directions for Environmental, Bio and Energy Applications", Advances in Liquid Separation Membranes and Applications at AIChE Annual Meeting, Cincinnati, OH, Paper No. 298a, October 30 – November 4, 2005.
12. Invited Keynote Lecture, "Facilitated Transport Membranes for Environmental and Energy Applications", North American Membrane Society 2006 Annual Meeting, Chicago, IL, May 15-17, 2006.
13. Invited Plenary Lecture, "CO_2-Selective Membranes for Hydrogen Purification", 2006 Conference on Membrane Science and Technology, Chung-Li, Taiwan, June 8-9, 2006.
14. Invited Keynote Lecture, "Removal and Recovery of Metals by Supported Liquid Membranes with Strip Dispersion", 2006 Conference on Membrane Science and Technology, Chung-Li, Taiwan, June 8-9, 2006.
15. Invited Plenary Lecture, "CO_2-Selective Membranes with Water Gas Shift Reaction for H_2 Purification", International Workshop on Process Intensification in Fluid and Particle Engineering, Kobe, Japan, Invited Keynote Lecture, October 15-18, 2006, Paper No. K201.
16. Invited Plenary Lecture, "Synthesis and Characterization of Sulfonated Polyimides and Copolymers as Proton-Exchange Membranes for Fuel Cells", ACS Symposium on Advances in Materials for Proton Exchange Membrane Fuel Cell Systems, Pacific Grove, CA, February 18-21, 2007.
17. Invited Plenary Lecture, "New Membranes for Fuel Cells", Fourth Conference of Aseanian Membrane Society, Taipei, Taiwan, August 16-18, 2007.
18. Invited Plenary Lecture, "Membranes for CO_2 Separation/Capture and Regeneration", Navy CO_2 Capture and Regeneration Workshop, Office of Naval Research, Washington, DC, September 26, 2007.
19. Invited Plenary Lecture, "Carbon Dioxide-Selective Membrane for Hydrogen Purification and Carbon Dioxide Capture", 137th Annual Meeting of The Minerals, Metals and Materials Society (TMS), New Orleans, LA, March 9-13, 2008.
20. Invited Keynote Lecture, "Recent Developments on Membranes for Water Purification", International Membrane Conference in Taiwan, Chung-Li, Taiwan, June 27-28, 2008.
21. Invited Keynote Lecture, "New Polymer Membranes for Hydrogen Purification and Proton Transport for Fuel Cells", Macro 2008, Polymers at Frontiers of Science and Technology, Taipei, Taiwan, June 29-July 4, 2008.
22. Invited Keynote Lecture, "Carbon Dioxide-Selective Membranes and Carbon Capture", Carbon Capture and Sequestration Conference, New Industrial Chemistry and Engineering, the Council for Chemical Research, Houston, TX, October 13-14, 2008.
23. Invited Keynote Lecture, "H_2S- and CO_2-Selective Membranes for Fuel Processing for Fuel Cells", 238th ACS National Meeting, Washington, DC, August 16-19, 2009.
24. Invited Keynote Lecture, "New Membranes for Hydrogen Purification and Proton Transport for Fuel Cells", 5th China-US Conference of Chemical Engineering, Beijing, China, October 12-16, 2009.
25. Invited Keynote Lecture, "New Membranes for Fuel Cells and Carbon Capture", International Membrane Conference, Chung-Li, Taiwan, May 26-28, 2010.
26. Invited Plenary Lecture, "New Membranes for Energy and Bio Applications", Gerhold Award Plenary Session on Separations at AIChE Annual Meeting, Salt Lake City, UT, Paper No. 23e, November 7-12, 2010.

27. Invited Plenary Lecture, "New Membranes for CO_2 Separation and H_2 and Water Purification", the 9th Membrane Science and Technology (MST) Conference, Singapore, August 23-25, 2011.
28. Invited Plenary Lecture, "Membrane Science and Technology: CO_2 Separation and Water Purification", the 13th Annual Meeting of China Association for Science & Technology, Tianjin, China, September 21-23, 2011.
29. Invited Keynote Lecture, "Facilitated Transport Membranes for Energy and Bio Applications", 6th China-US Conference of Chemical Engineering, Beijing, China, November 6-10, 2011.
30. Invited Keynote Lecture, "New Membranes for CO_2 and Water Separations", The Third Sustainable Green Technology Symposium, Taipei, Taiwan, June 30, 2012.
31. Invited Keynote Lecture, "High Flux RO Membranes for Brackish Water Desalination", Euromembrane, London, UK, Paper No. K08, September 23 – 27, 2012.
32. Invited Keynote Lecture, "New Developments on Membranes for CO_2 Separation and Capture", 7th China-U.S. Conference of Chemical Engineering, Beijing, China, October 14-18, 2013.
33. Invited Plenary Lecture, "New Advances in Membranes for Antibiotic Recovery and Controlled Release", Gerhold and Kunesh Award Plenary Session on Separations, 2013 AIChE Annual Meeting, San Francisco, CA, Paper No. 54c, November 3-8, 2013.
34. Invited Plenary Lecture, "New Developments on Membranes for CO_2 Separation and Capture", Plenary Session on Advanced Separations for Sustainability III, 2013 AIChE Annual Meeting, San Francisco, CA, Paper No. 226a, November 3-8, 2013.
35. Invited Keynote Lecture, "New Membranes for CO_2 Separation/Capture and Water Purification", Green Energy Symposium, Taipei, Taiwan, June 30, 2014.
36. Invited Keynote Lecture, "New Membranes for Carbon Dioxide Separation and Capture", 10th International Congress on Membranes and Membrane Processes, Suzhou, China, July 20-25, 2014.
37. Invited Keynote Lecture, "New Scale-up Membranes for CO_2 Capture and Separation", 8th China-U.S. Conference of Chemical Engineering, Shanghai, China, October 12-16, 2015.
38. Invited Keynote Lecture, "New Fouling-Resistant High-Flux Membranes for Seawater Desalination", 8th China-U.S. Conference of Chemical Engineering, Shanghai, China, October 12-16, 2015.
39. Invited Keynote Lecture, "New Scale-up Membranes for CO_2 Capture and Separation", Inaugural Indo-US Symposium on Carbon Capture, Sequestration, Utilization and Other Frontiers, CHEMCON 2015 (Annual Meeting of the Indian Institute of Chemical Engineers), Guwahati, Assam, India, December 27 – 30, 2015.
40. Invited Plenary Lecture, "Recent Developments on Membranes for CO_2 Separation and Water Purification", 26th Annual Meeting of NAMS (North American Membrane Society), Bellevue, Washington, May 21-25, 2016.
41. Invited Plenary Lecture, "New Membranes for Brackish and Sea Water Desalination", International Membrane Technology and Water Treatment Conference, Huzhou, China, June 12-14, 2016.
42. Invited Keynote Lecture, "New Scale-up CO_2-Selective Membranes for H_2 Purification and CO_2 Capture", The 7th Sustainable Green Technology Symposium, Taipei, Taiwan, July 8, 2016.

43. Invited Plenary Lecture, "New Amine-Containing Membranes for CO_2 Capture and Separation", Indo-US Symposium on Separation Science and Technology, CHEMCON 2016 (Annual Meeting of the Indian Institute of Chemical Engineers), Chennai, Tamil Nadu, India, December 27 – 30, 2016.
44. Invited Keynote Lecture, "New Amine-Containing Membranes for CO_2 Capture", Carbon Capture and Utilization Conference, National Taiwan University, Taipei, Taiwan, May 15 – 17, 2017.
45. Invited Plenary Lecture, "New Amine-Containing Membranes for H_2 Purification and CO_2 Capture", International Green Chemical Engineering Summit 2017 (IGCES 2017), Beijing, China, October 17, 2017.
46. Invited Keynote Lecture, "New Amine-Based Facilitated Transport Membranes for CO_2 Capture", 9th China-U.S. Conference of Chemical Engineering, Beijing, China, October 15-19, 2017.
47. Invited Plenary Lecture, "New Membranes for CO_2 Capture and Water Purification", Green Process Engineering Innovation Leadership Award Lecture, Topical Conference on Frontiers in Green Process Engineering for Sustainable Energy and Environment, Paper No. 306c, AIChE Annual Meeting, Pittsburgh, PA, October 28 – November 2, 2018.
48. Invited Plenary Lecture, "Recent Developments on Membranes for Brackish and Sea Water Desalination", 6th West Lake International Conference on Desalination and Water Reuse, Hangzhou, China, November 10 – 11, 2018.
49. Invited Keynote Lecture, "New Amine-Based Facilitated Transport Membranes for CO_2 Capture", 8th Symposium for Innovative CO_2 Membrane Separation Technology, Tokyo, Japan, January 18, 2019.
50. Invited Keynote Lecture, "Facilitated Transport Membranes for H_2 Purification from Coal-Derived Syngas", Paper No. K13A.01, 12th International Congress on Membranes and Membrane Processes, London, United Kingdom, online, December 7-11, 2020.
51. Invited Keynote Lecture, "Overview of CO_2 Capture Technologies: Great Progress on Membranes", International Symposium on Carbon Capture and Sequestration at the Indian Institute of Technology Guwahati, India, online, February 21-22, 2022.
52. Invited Plenary Lecture, "CO_2 Capture: Membrane and Other Technologies", Annual Conference of Science, Engineering and Technology Seminars of the Association of Chinese American Professionals, Houston, Texas, June 4, 2022.
53. Invited Keynote Lecture, "New Amine-Based Membranes for CO_2 Capture from Flue Gas and Syngas", Taiwan Symposium on Carbon Capture, Taipei, Taiwan, July 12, 2022.
54. Invited Keynote Lecture, "CO_2 Capture: From Absorption to Membrane Process", Online Webinar Series Commemorating 20 Years of the Department of Chemical Engineering, Indian Institute of Technology Guwahati, January 23 – 27, 2023.
55. Invited Plenary Lecture, "New Transformational Membranes for CO_2 Capture from Flue Gases", 7th International Conference on CO_2 Emission Control & Utilization (ICCU-7), Chengdu, China, online, October 27 - 29, 2023.
56. Invited Plenary Lecture, "New Facilitated Transport Membrane and Process for CO_2 Capture from Flue Gas", Plenary Session in Honor of the 2021 R.H. Wilhelm Award Winner I, Symposium Honoring Professor Yushan Yan, Paper No. 285a, AIChE Annual Meeting, Orlando, FL, November 5 - 10, 2023.

Invited Seminars Given at Conferences, Universities and Industrial and Government Research Laboratories

- Invited speaker on membranes and separations at the China-USA Chemical Engineering Conferences, International Congresses on Membranes and Membrane Processes, Gordon Research Conferences, Engineering Foundation Conferences, and AIChE, NAMS, ACS, and AESF (American Electroplaters and Surface Finishers) meetings.
- Invited seminars at more than 50 universities: Beijing University of Chemical Technology (3 seminars), Case Western Reserve University, Chang Gung University, Chung Yuan University (4 seminars), Colorado State University, East China University of Science and Technology (2 seminars), Gwangju Institute of Science and Technology (Korea), Hong Kong University, Huazhong University of Science and Technology (2 seminars), Illinois Institute of Technology, University of Kentucky (2 seminars), Lehigh University, Nanjing University of Technology, National Central University, National Chiao Tung University, National Taiwan University (7 seminars), National Taiwan University of Science and Technology, National Tsing Hua University (2 seminars), New Jersey Institute of Technology, Ocean University of China (3 seminars), The Ohio State University, Oklahoma State University, The Pennsylvania State University, Polytechnic University, Polytechnic University of Milan, Purdue University, Shanghai Advanced Research Institute (2 seminars), Soochow University (Taiwan), Stevens Institute of Technology, Stony Brook University, Tianjin Polytechnic University (7 seminars), Tianjin University (18 seminars), University of Arkansas, University of Bologna (4 seminars), University of Buffalo, University of California at Los Angeles, University of California at Riverside, University of Cincinnati, University of Connecticut (2 seminars), University of Illinois at Urbana-Champaign, University of Louisville, University of Missouri-Columbia, University of Missouri-Rolla, University of Notre Dame, University of Pennsylvania, University of Rome, University of Toledo, Tsinghua University (9 seminars), Waterloo Institute for Nanotechnology at the University of Waterloo, Worcester Polytechnic Institute, Xi'an Jiaotong University (4 seminars), Xi'an University of Architecture and Technology, Yuan Ze University (2 seminars), Zhejiang University (5 seminars), Zhejiang University of Technology (3 seminars), Zhengzhou University, and Zhongkai University of Agriculture and Engineering (2 seminars).
- Invited seminars at industrial, governmental and other research laboratories, including Academia Sinica (Taiwan, 2 seminars), Argonne National Laboratory, Battelle, Bloom Energy Corporation, Center for Applied Energy Research, Lexington, KY, Center for Waste Reduction Technologies, China Academy of Engineering Physics (Mianyang, Sichuan, China), China Institute of Atomic Energy (Beijing), China Petroleum Corporation (Taiwan, 2 seminars), China Textile Institute (Taiwan), Dow Chemical Company, Corning, Inc., Cytec Industries Inc., Gas Technology Institute, GE Global Research Center (Irvine, CA), GE Global Research Center (Niskayuna, NY), HydrogenSource LLC/UTC, Industrial Technology Research Institute (Taiwan), Institute of Coal Chemistry at the Chinese Academy of Sciences, Institute of Nuclear Energy Research (Taiwan), National Institute of Standards and Technology, Research Institute of Innovative Technology for the Earth (RITE, Japan), San Fu Chemical Company (Taiwan), Shell Oil Products Company, and UOP, LLC.

Editor and Member of Editorial and Advisory Boards of Technical Journals

- Invited Editor, Separation Engineering Section, Current Opinion in Chemical Engineering, 2011-now.
- Invited Member, Editorial Board, Separation Engineering Section, Current Opinion in Chemical Engineering, 2011-now.
- Invited Member, Editorial Board, Energy & Environmental Engineering Section, Current Opinion in Chemical Engineering, 2011-now.
- Invited Member, Editorial Board, Journal of Membrane Science, 2004-2023.
- Invited Member, Editorial Board, Membrane Science and Technology, 2003-now.
- Invited Member, Editorial Board, Membranes, 2020-now.
- Invited Member, Advisory Board, Journal of Membrane Science, 2023-now.

National and International Technical Panels and Committees Served

- Invited member of the NSF Review Panel on Gas Separations, 1994.
- Invited panel member at the MIT-DOE Workshop on a research needs assessment on energy-related applications using nanostructured materials, 1995.
- Invited reviewer on separations proposals for the State of Ohio, 1997.
- Invited member of AIChE Publication Committee, 1996-1998.
- Chairman, By-Laws Operating Committee, AIChE Separations Division, 1992-1998.
- Invited panel member at the NIST Advanced Technology Program National Meeting Workshop on Membrane/Separations Technologies, 1999.
- Invited member of the Executive Board of Programming Committee, AIChE, 2000-2003.
- Invited member of the NSF Review Panel on Bioprocessing and Industrial Bioproducts, 2002.
- Invited member of the NSF Review Panel on Technology for a Sustainable Environment, 2003.
- Invited member of the NSF Review Panel on Fuel Cells, 2004.
- Invited member of the NSF Review Panel on Separation and Purification Processes, 2005.
- Invited member of the DOE Science Review Panel on Proton Exchange and Hydrogen Purification Membranes, March 12-13, 2007.
- Invited member of the Executive Board of Programming Committee, AIChE, 2007-2009.
- Invited panel member at the Workshop on Research Frontiers relevant to membrane engineers and scientists, the Annual Meeting of North American Membrane Society, Charleston, SC, June 21-24, 2009.
- Invited member, Industrial Innovation Award Committee, AIChE, 2008-2009.
- Invited member of the Review Panel on the Chemical Engineering Program at the University of Cincinnati, OH, 2010.
- Invited member of the NSF Review Panel on Separations, 2010 and 2011.
- Invited member of the Societal Impact Operating Council, AIChE, 2004-2014.
- Invited member, Awards Committee, North American Membrane Society, 2006-now.
- Invited member, Spring National and Annual Meeting Site Selection Committee, AIChE, 2009-2018.
- Invited member, Institute Award Committee, AIChE, 2008-2016.

- Invited member of the Review Panel on the Chemical Engineering Program at National Taiwan University, Taipei, Taiwan, April 12-13, 2012.
- Invited member, National Research Council panel on energy and water, 2013.
- Invited member, Alan Michaels Awards Committee, North American Membrane Society, 2013.
- Invited member of the Review Panel on the Center Competitive Funding program at the King Abdullah University of Science and Technology (KAUST), Thuwal, Kingdom of Saudi Arabia, December 12-16, 2013.
- Invited member of the Executive Board of Programming Committee, AIChE, 2012-now, Second Vice Chair for 2013, First Vice Chair for 2014, Chair for 2015, Immediate Past Chair for 2016.
- Invited member of the Review Panel on the Competitive Research Grant (CRG) program at the King Abdullah University of Science and Technology (KAUST), Thuwal, Kingdom of Saudi Arabia, October 22-24, 2016.
- Invited member of the NSF Review Panel on Membranes, Washington, DC, February 16 – 17, 2017.
- Invited member of the DOE Office of Science Proposal Review on CO_2 Capture, Conversion, Utilization and Storage, Washington, DC, June 6 – 7, 2022.

Conferences/Meetings and Sessions Organized and Chaired

- Organized and chaired conferences, symposia and sessions on membranes and separations at the China-USA Chemical Engineering Conferences, India-USA Chemical Engineering Conference, International Congresses on Membranes and Membrane Processes, Engineering Foundation Conferences, and ACS, AIChE and NAMS meetings.
- Conference Chairman, Topical Conference on Separation Science and Technologies at the AIChE Annual Meeting in Los Angeles, CA on November 16-21, 1997 – 45 sessions with more than 400 papers and 1750-pages preprints, the largest, most comprehensive conference on separations ever organized.
- Co-Chairman (invited), Mass Transfer and Separation Technology Symposium, Third Joint China / USA Chemical Engineering Conference, Beijing, China, September 25-28, 2000.
- Chairman (invited) of Membrane Formation and New Materials and invited member of the Organizing Committee for the Engineering Foundation Conference on Advanced Membrane Technology, Barga, Italy, October 14-19, 2001.
- Invited Member of the Scientific Committee and Chairman of Fuel Cell Membranes Symposium, International Congress on Membranes and Membrane Processes, Toulouse, France, July 7-12, 2002.
- Invited Chair, Novel Membranes and Membrane Processes for Recovery/Recycle Session, AIChE Annual Meeting, Indianapolis, IN, November 3 - 8, 2002.
- Chairman (invited) of Advanced Extraction and Stripping Technologies and invited member of the Organizing Committee for the Engineering Foundation Conference on Water Purification and Reuse, Potsdam, Germany, June 8-13, 2003.
- Conference Co-Chairman, Topical Conference on Advanced Membrane-Based Separations at the AIChE Annual Meeting, San Francisco, November 16-21, 2003.

- Invited Chair, Fuel Cell Membranes Session, AIChE Annual Meeting, San Francisco, November 16 - 21, 2003.
- Invited Session Chair, Fuel Cell Membranes, AIChE Annual Meeting, Austin, TX, November 7-12, 2004.
- Co-Chairman (invited), Membranes Symposium, First Joint India-USA Chemical Engineering Conference, Mumbai, India, December 28-30, 2004.
- Invited Session Chair, Membranes II, First India-USA Joint Chemical Engineering Conference, Mumbai, India, December 28-30, 2004.
- Invited Workshop Co-Chairman, The First China-USA Workshop on Chemical Engineering, Beijing, China, August 10-12, 2005, sponsored by National Science Foundation, USA.
- Co-Chairman (invited), International Membrane Conference, Chung-Li, Taiwan, August 18-19, 2005.
- Invited Session Chair, Plenary Session, 2005 International Membrane Conference, Chung-Li, Taiwan, August 18-19, 2005.
- Invited Session Chair, Catalytic Membranes and Membrane Reactors, 2005 International Congress on Membranes and Membrane Processes, Seoul, Korea, August 21-26, 2005.
- Co-Chairman (invited), Separation Science and Technology Symposium, Joint China / USA / Japan Chemical Engineering Conference, Beijing, China, October 11-13, 2005.
- Invited Session Chair, Fuel Cell Membranes I, Session No. 214, AIChE Annual Meeting, Cincinnati, OH, October 30 - November 4, 2005.
- Invited Session Chair, Fuel Cell Membranes II, Session No. 353, AIChE Annual Meeting, Cincinnati, OH, October 30 - November 4, 2005.
- Co-Chairman, Chinese-American Chemical Society 25th Anniversary Symposium, 231st ACS National Meeting, Atlanta, GA, March 26-30, 2006.
- Invited Co-Chairman, The Second China-USA Workshop on Chemical Engineering, Durham, NH, August 20-23, 2006, sponsored by National Science Foundation, USA.
- Invited Session Chair, Fuel Cell Membranes I, AIChE Annual Meeting, San Francisco, CA, November 12-17, 2006.
- Invited Session Co-Chair, Membranes for Hydrogen Purification, AIChE Annual Meeting, San Francisco, CA, November 12-17, 2006.
- Invited Session Chair, Fuel Cell Membranes I, AIChE Annual Meeting, Salt Lake City, UT, November 4-9, 2007.
- Invited Session Chair, Keynote Lecture Session on Membrane Formation, International Membrane Conference in Taiwan, Chung-Li, Taiwan, June 27-28, 2008.
- Invited Session Chair, Plenary Session on Fuel Cell Membranes, Macro 2008, Polymers at Frontiers of Science and Technology, Taipei, Taiwan, June 29-July 4, 2008.
- Invited Session Chair, Fuel Cell Membranes I, Session No. 32, AIChE Annual Meeting, Philadelphia, PA, November 16-21, 2008.
- Invited Session Chair, Fuel Cell Membranes II, Session No. 413, AIChE Annual Meeting, Philadelphia, PA, November 16-21, 2008.
- Invited Session Chair, Fuel Cell Membranes III, Session No. 647, AIChE Annual Meeting, Philadelphia, PA, November 16-21, 2008.
- Invited Member, Scientific Advisory Committee, 5th China-US Conference of Chemical Engineering, Beijing, China, October 12-16, 2009.

- Co-Chairman (invited), Separations and Environmental Technology Symposium, 5th China-US Conference of Chemical Engineering, Beijing, China, October 12-16, 2009.
- Invited Session Chair, Separations and Environmental Technology Symposium, Session No. 06SPE-B, 5th China-US Conference of Chemical Engineering, Beijing, China, October 12-16, 2009.
- Invited Session Chair, Separations and Environmental Technology Symposium, Session No. 06SPE-D, 5th China-US Conference of Chemical Engineering, Beijing, China, October 12-16, 2009.
- Session Chair, AIChE 2009 Annual Meeting Plenary Session - Looking Forward - Energy Policy & Technology, Session No. 6, AIChE Annual Meeting in Nashville, TN, November 8-13, 2009.
- Invited Session Chair, AIChE 2009 Institute Lecture, Session No. 388, AIChE Annual Meeting in Nashville, TN, November 8-13, 2009.
- Invited Session Chair, AIChE 2009 Corporate Innovation Lecture, Session No. 543, AIChE Annual Meeting in Nashville, TN, November 8-13, 2009.
- Invited Session Chair, Polymer Membranes for CO_2 Capture, International Membrane Conference, Chung-Li, Taiwan, May 26-28, 2010.
- Invited Session Chair, Gas Separations 3, Session No. 39, the First Joint Meeting of North American Membrane Society and International Conference of Inorganic Membranes, Washington, DC, July 18-22, 2010.
- Invited Session Chair, Fuel Cell Membranes I, Session No. 277, AIChE Annual Meeting, Salt Lake City, UT, November 7-12, 2010.
- Invited Session Co-Chair, Fuel Cell Membranes II, Session No. 329, AIChE Annual Meeting, Salt Lake City, UT, November 7-12, 2010.
- Invited Symposium Chair, E. V. Murphree Award Symposium in Industrial and Engineering Chemistry: Symposium in Honor of Norman N. Li, the 241st ACS (Spring) National Meeting in Anaheim, CA, March 27-31, 2011.
- Invited Session Chair, Session IEC027a, E. V. Murphree Award in Industrial and Engineering Chemistry: Symposium in Honor of Norman N. Li – I, the 241st ACS (Spring) National Meeting in Anaheim, CA, March 27-31, 2011.
- Invited Session Co-Chair, Session IEC027d, E. V. Murphree Award in Industrial and Engineering Chemistry: Symposium in Honor of Norman N. Li – IV, the 241st ACS (Spring) National Meeting in Anaheim, CA, March 27-31, 2011.
- Invited Session Chair, Membrane Formation I, the Annual Meeting of North American Membrane Society, Las Vegas, NV, June 4-8, 2011.
- Invited Session Chair, Facilitated Transport Membranes 1, Session 4, International Congress on Membranes and Membrane Processes in Amsterdam, The Netherlands, July 23-29, 2011.
- Invited Session Chair, Fuel Cell Membranes I, Session No. 452, AIChE Annual Meeting, Minneapolis, MN, October 16-21, 2011.
- Invited Session Co-Chair, Fuel Cell Membranes II, Session No. 528, AIChE Annual Meeting, Minneapolis, MN, October 16-21, 2011.
- Invited Member, Scientific Advisory Committee, 6th China-US Conference of Chemical Engineering, Beijing, China, November 6-10, 2011.

- Invited Co-Chairman, Symposium on Resources and Green Technologies, 6th China-US Conference of Chemical Engineering, Beijing, China, November 6-10, 2011.
- Invited Session Chair, Session 4-A on Resources and Green Technologies, 6th China-US Conference of Chemical Engineering, Beijing, China, November 6-10, 2011.
- Invited Session Chair, Membrane Formation II, the Annual Meeting of North American Membrane Society, New Orleans, LA, June 9-13, 2012.
- Invited Symposium Co-Chair, the Third Sustainable Green Technology Symposium, Taipei, Taiwan, June 30, 2012.
- Invited Session Chair, Underground Thermal Energy Storage and Carbon Capture, the Third Sustainable Green Technology Symposium, Taipei, Taiwan, June 30, 2012.
- Session Chair, Fuel Cell Membranes I, Session No. 635, AIChE Annual Meeting, Pittsburg, PA, October 28-November 2, 2012.
- Session Co-Chair, Fuel Cell Membranes II, Session No. 697, AIChE Annual Meeting, Pittsburg, PA, October 28-November 2, 2012.
- Invited Member, Scientific Advisory Committee, 7th China-US Conference of Chemical Engineering, Beijing, China, October 14-18, 2013.
- Co-Chairman (invited), Symposium on Resources and Green Technologies, 7th China-U.S. Conference of Chemical Engineering, Beijing, China, October 14-18, 2013.
- Invited Session Chair, Session I on Resources and Green Technologies, 7th China-U.S. Conference of Chemical Engineering, Beijing, China, October 14-18, 2013.
- Invited Member, International Scientific Committee, 10th International Congress on Membranes and Membrane Processes, Suzhou, China, July 20-25, 2014.
- Invited Session Chair, Gas Separation – Carbon Dioxide Capture I, 10th International Congress on Membranes and Membrane Processes, Suzhou, China, July 20-25, 2014.
- Session Chair, Fuel Cell Membranes, Session No. 560, AIChE Annual Meeting, Atlanta, GA, November 16-21, 2014.
- Invited Member, Scientific Advisory Committee, 8th China-US Conference of Chemical Engineering, Shanghai, China, October 12-16, 2015.
- Co-Chairman (invited), Green Technology Symposium, 8th China-U.S. Conference of Chemical Engineering, Shanghai, China, October 12-16, 2015.
- Session Chair, Fuel Cell Membranes, Session No. 588, AIChE Annual Meeting, Salt Lake City, UT, November 8-13, 2015.
- Invited Member, International Advisory Committee, CHEMCON 2015 (Annual Meeting of the Indian Institute of Chemical Engineers), Guwahati, Assam, India, December 27 – 30, 2015.
- Chairman (invited), Inaugural Indo-US Symposium on Carbon Capture, Sequestration, Utilization and Other Frontiers, CHEMCON 2015 (Annual Meeting of the Indian Institute of Chemical Engineers), Guwahati, Assam, India, December 27 – 30, 2015.
- Invited Session Chair, Transport, Modeling and Gas Separations, Engineering Foundation Conference on Advanced Membrane Technology VII, Cork, Ireland, September 11-16, 2016.
- Session Chair, Fuel Cell Membranes, Session No. 213, AIChE Annual Meeting, San Francisco, CA, November 13-18, 2016.
- Session Co-Chair, Membranes for Gas Separations II, Session No. 537, AIChE Annual Meeting, San Francisco, CA, November 13-18, 2016.

- Co-Chairman (invited), The Indo-US Symposium on Separations Science and Technology, CHEMCON 2016 (Annual Meeting of the Indian Institute of Chemical Engineers), Chennai, Tamil Nadu, India, December 27 – 30, 2016.
- Invited Scientific Committee Member, Engineering Foundation ECI Conference on Separations Technology IX, Albufeira, Portugal, March 5-10, 2017.
- Invited Session Chair, Membrane Separations – 3, Engineering Foundation ECI Conference on Separations Technology IX, Albufeira, Portugal, March 5-10, 2017.
- Invited Scientific Committee Member, 9th Global Chinese Chemical Engineering Symposium, Hangzhou, Zhejiang, China, July 18-21, 2017.
- Invited Member, International Scientific Committee, 11th International Congress on Membranes and Membrane Processes, San Francisco, CA, USA, July 29-August 4, 2017.
- Invited Member, Scientific Advisory Committee, 9th China-US Conference of Chemical Engineering, Beijing, China, October 15-19, 2017.
- Invited Session Chair, Separation Technology Session III, 9th China-U.S. Conference of Chemical Engineering, Beijing, China, October 15-19, 2017.
- Invited Session Chair, Plenary Session I, International Green Chemical Engineering Summit 2017 (IGCES 2017), Beijing, China, October 17, 2017.
- Session Chair, Fuel Cell Membranes, Session No. 220, AIChE Annual Meeting, Minneapolis, MN, October 29 - November 3, 2017.
- Session Chair, Mixed-Matrix Membranes for Gas Separation, Session No. 610, AIChE Annual Meeting, Minneapolis, MN, October 29 - November 3, 2017.
- Session Chair, Membranes for Energy Applications (Storage Batteries to Fuel Cells), Session No. 22, The Annual Meeting of North American Membrane Society, Lexington, KY, June 10 – 13, 2018.
- Session Chair, Fuel Cell Membranes, Session No. 28, AIChE Annual Meeting, Pittsburgh, PA, October 28 - November 2, 2018.
- Session Chair, Membranes for CO_2 Capture, Session No. 628, AIChE Annual Meeting, Pittsburgh, PA, October 28 - November 2, 2018.
- Session Co-Chair, Applications: Assessing Performance, Robustness, and Scalability for Carbon Capture, Session No. 6, The Annual Meeting of North American Membrane Society, Pittsburgh, PA, May 12 – 15, 2019.
- Session Co-Chair, Applications: Assessing Performance, Robustness, and Scalability for Carbon Capture, Session No. 7, The Annual Meeting of North American Membrane Society, Pittsburgh, PA, May 12 – 15, 2019.
- Session Chair, Membranes for CO_2 Capture, Session No. 27, AIChE Annual Meeting, Orlando, FL, November 10 – 15, 2019.
- Session Co-Chair, Carbon Capture I, The Annual Meeting of North American Membrane Society, Tempe, AZ, in the online format on May 18 – 21, 2020.
- Session Co-Chair, Carbon Capture II, The Annual Meeting of North American Membrane Society, Tempe, AZ, in the online format on May 18 – 21, 2020.
- Session Chair, Membranes for Electrochemical Conversions and Applications, Session No. 423, AIChE Annual Meeting, San Francisco, CA, in the online format on November 16 – 20, 2020.

- Session Chair, Membranes for Electrochemical Conversions and Applications, Session No. 482, AIChE Annual Meeting, San Francisco, CA, in the online format on November 16 – 20, 2020.
- Invited Member, International Scientific Committee, 12th International Congress on Membranes and Membrane Processes, London, UK, in the online format on December 7 – 11, 2020.
- Invited Session Chair, Session No. 13A – Gas Separation 10, 12th International Congress on Membranes and Membrane Processes, London, United Kingdom, in the online format on December 7 – 11, 2020.
- Session Chair, Membranes for Electrochemical Conversions and Applications I, Session No. 488, AIChE Annual Meeting, Boston, MA, November 7 – 11, 2021.
- Session Chair, Membranes for Electrochemical Conversions and Applications II, Session No. 535, AIChE Annual Meeting, Boston, MA, November 7 – 11, 2021.
- Invited Session Co-Chair, Carbon Capture I, The Annual Meeting of North American Membrane Society, Tempe, AZ, May 15 – 18, 2022.
- Invited Session Co-Chair, Carbon Capture II, The Annual Meeting of North American Membrane Society, Tempe, AZ, May 15 – 18, 2022.
- Invited Session Co-Chair, Advanced Membranes for Carbon Capture and Sustainability, Session No. 285, AIChE 2023 Annual Meeting, Orlando, FL, November 5-10, 2023.

Manuscript and Research Proposal Referee

- For AIChE Journal, Journal of Membrane Science, Industrial & Engineering Chemistry Research, Chemical Engineering Science, Journal of ACS, Current Opinion in Chemical Engineering, Separation Science and Technology, Separation and Purification Technology, ACS Applied Materials & Interfaces, ACS Books, Angewandte Chemie, Journal of Applied Polymer Science, Bioresource Technology, The Canadian Journal of Chemical Engineering, Chemical Engineering Education, Chemical Engineering Journal, Chemical Science, Chemistry of Materials, Journal of Colloid and Interface Science, Desalination, Desalination and Water Treatment, Environmental Progress, Environmental Technology, European Polymer Journal, Fluid Phase Equilibria, International Journal of Hydrogen Energy, Mathematical and Computer Modeling, Membrane Water Treatment, Journal of Porous Materials, Powder Technology, Reactive and Functional Polymers, Science Advances, Scientific Reports (Nature Publishing Group), Journal of the Taiwan Institute of Chemical Engineers, ACS, DOE, NSF, and NAMS.