



EDUCATIONAL HISTORY

The Pennsylvania State University, Chemical Engineering, Postdoc. **2016-**

Advisor: Dr. Enrique Gomez and Dr. Manish Kumar

The Pennsylvania State University, Chemical Engineering, Ph.D. **2011-2016**

Advisor: Dr. Manish Kumar

My Ph.D. have been a creative journey into exploring the potential of mimicking biological water channels and lipids using supramolecular chemistry and investigating them using biophysical techniques. This combined with my very practical focus on water and wastewater treatment during my undergraduate and MS research provides me powerful motivation to create unique solutions to the pressing issues of water pollution, scarcity and public health. In addition to my strong interest in technical ideas addressing water transport in all biological and synthetic systems, I am a visual artist and focus on creative visual communication ideas to enhance the impact of my research and to enrich my own personal life.

Tsinghua University, Environmental Engineering, Master of Science **2009-2011**

Advisor: Dr. Xia Huang

Tsinghua University, Water Supply and Sewer System Engineering, Bachelor of Science **2005- 2009**

Top student in class (1 of 77)

RESEARCH EXPERIENCE

Postdoctoral projects

- Characterization of polymeric materials using advanced surface characterizing technologies such as transmission electron microscopy and resonant soft X-ray scattering

Doctoral projects:

- Development of artificial water channel based-membranes for desalination and other environmental applications.
- Supported biomimetic desalination membranes based on incorporation of aquaporins into lipids and block copolymers.
- Transport study of light driven ion-transport membrane proteins—halorhodopsins.

Master's projects:

- Physiochemical and biological properties of mixed liquor in full-scale Membrane Bioreactors (MBRs) for municipal wastewater treatment, master thesis, 03/2010-06/2011
- Technologies and demonstration project on water environmental protection in rapid developing and urbanized areas in China, 10/2009-06/2011
- Collecting materials for 'The MBR Book: Principles and Applications of Membrane Bioreactors for Water and Wastewater Treatment' (Second Edition by Dr. Simon Judd), 01/2010

Undergraduate projects:

- Membrane fouling in a membrane bioreactor coupled with anaerobic-anoxic-oxic process for coke wastewater treatment, undergraduate thesis, 03/2009-06/2009
- Membrane fouling in MBR and MBR-NF system, 10/2007-06/2009
- Phosphorus removal in an Sequencing Batch Reactor, 07/2007-08/2007
- Particulate matter and its health impact in Beijing, 09/2006-06/2007

AWARDS & HONORS

- Chair of Gordon Research Seminar (GRS), Membranes: Materials & Processes, 2016-2018
- Poster Competition North American Membrane Society (NAMS), 2nd Prize, 2016
- Chinese Government Scholarship for Outstanding Self-financed Students Abroad, 2016 [\[link\]](#)
- Harold K. Schilling Dean's Graduate Scholarship, Penn State, 2016
- Best Paper Award, Department of Chemical Engineering, Penn State, 2015 [\[link\]](#)
- Poster Competition North American Membrane Society (NAMS), 1st Prize, 2015
- North American Membrane Society (NAMS) Student Fellowship Award, 2015
- American Institute of Chemical Engineers (AIChE) Separations Division Graduate Student Research Award, 2014 [\[link\]](#)
- One of the 8 student delegates selected nationwide for the Council for Chemical Research Conference, 2014
- Teaching Fellow, Department of Chemical Engineering, Unit operations class, Penn State, 2014
- Leighton Reiss Graduate Fellowship, Penn State, 2013
- **Shen, Y.**, Saboe, P., Ferlez, B., Erbakan, M. & Escotet, M. Solar energy based biomimetic water desalination and purification. 28th

- Annual Graduate Exhibition at Penn State. 2nd Prize, 2013
- **Shen, Y.**, Saboe, P., Ferlez, B., Erbakan, M. & Escotet, M. Solar energy based biomimetic water desalination and purification. Dow Sustainability Innovation Challenge. 2nd Prize at Penn State, 2012 [[link](#)]
- Larson Aquatic Research Support Doctoral Scholarship, American Water Works Association, 2012
- The First-Class Scholarship of Tsinghua-Meishang International Scholarship, 2010
- Excellent undergraduate student, Tsinghua University, 2009
- Excellent undergraduate thesis, Tsinghua University, 2009
- Member of youngsters' scientific and technological innovation plan in Tsinghua University, 2008-2009
- National Scholarship, China, 2007 and 2008
- Gold Medal of Practical Investigation Contest in Tsinghua University with the project "Survey on the energy efficiency of buildings in Beijing", 2007
- The First-Class Scholarship of Tsinghua-POSCO Scholarship, 2006

PUBLICATIONS

First author publications

1. **Shen, Y.** et al. Fabrication of a lamellar block copolymer membrane with highly permeable artificial channels. (in preparation)
2. **Shen, Y.** et al. Highly permeable artificial water channels in block copolymer membranes. (in preparation)
3. **Shen, Y.** et al. OmpF two-dimensional crystals as filtration materials. (in preparation)
4. **Shen, Y.**, Sun, Y., Yang, Y., Zhou, J. & Huang, X. Functional gene diversity of microbial communities in 10 large-scale membrane bioreactors for municipal wastewater treatment in China. *ISME J.* (in preparation)
5. Sun, Y., **Shen, Y.**, Liang, P., Zhou, J., Yang, Y. & Huang, X. Multiple antibiotic resistance genes distribution in ten large-scale membrane bioreactors for municipal wastewater treatment. *Bioresour. Technol.* 222, 100-106, (2016). [[link](#), **co-first author**]
6. Licsandru, E., Kocsis, I., **Shen, Y.**, Murail S., Legrand, Y., Lee, A., Tsai, D., Baaden M., Kumar, M. & Barboiu, M. Salt excluding artificial water channels reveal enhanced dipolar water and proton translocation. *J. Am. Chem. Soc.* 138, 5403-5409, (2016). [[link](#), **co-first author**]
7. **Shen, Y.**, Si, W., Erbakan, M., Decker, K., Zorzi, R., Saboe, P., Kang, Y., Majd, S., Butler, P., Walz, T., Aksimentiev, A., Hou, J. & Kumar, M. Highly permeable artificial water channels that can self-assemble into two-dimensional arrays. *Proc. Natl. Acad. Sci. U.S.A.* 112, 9810-9815, (2015). [[link](#), [Penn State news](#) and other science websites]
8. **Shen, Y.**, Saboe, P., Sines, I., Erbakan, M. & Kumar, M. Biomimetic membranes: A review. *J. Membr. Sci.* 454, 359-381 (2014). [[link](#), one of the most downloaded *J. Membr. Sci.* articles]
9. Sun, Y., **Shen, Y.**, Liang, P., Zhou, J., Yang, Y. & Huang, X. Linkages between microbial functional potential and wastewater constituents in large-scale membrane bioreactors for municipal wastewater treatment. *Water Res.* 56, 162-171 (2014). [[link](#), **co-first author**]
10. **Shen, Y.**, Xiao, K., Liang, P., Ma, Y. & Huang, X. Improvement on Modified Lowry Method against Interference by divalent cations for soluble protein measurement in wastewater systems. *Appl. Microbiol. Biotechnol.* 97, 4167-4178 (2013). [[link](#)]
11. **Shen, Y.**, Xiao, K., Liang, P., Sun, J., Sai, S. & Huang, X. Characterization of soluble microbial products in 10 large-scale membrane bioreactors for municipal wastewater treatment in China. *J. Membr. Sci.* 415-416, 336-345 (2012). [[link](#)]
12. **Shen, Y.**, Zhao, W., Xiao, K. & Huang, X. A systematic insight into fouling propensity of soluble microbial products in membrane bioreactors based on hydrophobic interaction and size exclusion. *J. Membr. Sci.* 346, 187-193 (2010). [[link](#)]
13. **Shen, Y.**, Wang, Li., Mo, Y., Huang, X. & Wen, X. State of the art of membrane bioreactors. *China Water and Wastewater* 26 (12), 22-27 (2010). (in Chinese)
14. **Shen, Y.**, Wang, Li., Mo, Y., Huang, X. & Wen, X. State of the art of membrane fouling and membrane materials. *China Water and Wastewater* 26 (14), 22-27 (2010). (in Chinese)
15. **Shen, Y.**, Wang, Li., Mo, Y., Huang, X. & Wen, X. State of the art of microfiltration, ultrafiltration, nanofiltration and reverse osmosis technologies. *China Water and Wastewater* 26 (22), 1-6 (2010). (in Chinese)

Co-author publications

16. Xiao, K., **Shen, Y.**, Liang, P. & Huang, X. Synergistic effect of membrane and foulant properties on fouling evolution and irreversibility during microfiltration of soluble microbial products. *Environ. Sci. Technol.* (in preparation)
17. Mo, Y., Zhao, X. & **Shen, Y.** Cation-dependent structural instability of graphene oxide membranes and its effect on membrane separation performance. *Desalination.* 399, 40-46, (2016). [[link](#)]
18. Xiao, K., Sun, J., **Shen, Y.**, Liang, S., Liang, Peng. & Huang, X. Fluorescent properties of dissolved organic matter as functions of hydrophobicity and molecular weight? Case studies from two membrane reactors and an oxidation ditch. *RSC Adv.* 6, 24050-24059, (2016). [[link](#)]
19. Sun, J., Xiao, K., Yan, X., Liang, P., **Shen, Y.**, Zhu, N. & Huang, X. Membrane bioreactor vs. oxidation ditch: full-scale long-term performance related with mixed liquor seasonal characteristics. *Process Biochem.* 50, 2224-2233, (2015). [[link](#)]
20. Grzelakowski, M., Cherenet, M., **Shen, Y.** and Kumar, M. A framework for accurate evaluation of the promise of aquaporin based biomimetic membranes. *J. Membr. Sci.* 479, 223-231 (2015). [[link](#)]
21. Xiao, K., **Shen, Y.**, Liang, S., Liang, P., Wang, X., & Huang, X. A systematic analysis of fouling evolution and irreversibility behaviors

- of MBR supernatant hydrophilic/hydrophobic fractions during microfiltration. *J. Membr. Sci.* 467, 206-216 (2014). [[link](#)]
22. Erbakan, M., **Shen, Y.**, Grzelakowski, M., Butler, P., Kumar, M., Curtis, W. Molecular Cloning, Overexpression and Characterization of a Novel Water Channel Protein from *Rhodobacter sphaeroides*, *Plos One.* 9, e86830 (2014). [[link](#)]
 23. Kaufman, Y., Grinberg, S., Linder, C., Heldman, E., Gilron, J., **Shen, Y.**, Kumar, M., Lammertink, R. & Freger, V. Towards supported bolaamphiphile membranes for water filtration: Roles of lipid and substrate. *J. Membr. Sci.* 457, 50-61 (2014). [[link](#)]
 24. Sun, J., Xiao, K., Mo Y., Liang, P., **Shen, Y.**, Zhu, N. & Huang, X. Seasonal characteristics of supernatant organics and its effect on membrane fouling in a full-scale membrane bioreactor. *J. Membr. Sci.* 453, 168-174 (2014). [[link](#)]
 25. Kumar, M., Habel, J., **Shen, Y.**, Meier, W.P. & Walz, T. High-density reconstitution of functional water channels into vesicular and planar block copolymer membranes. *J. Am. Chem. Soc.* 134, 18631-18637 (2012). [[link](#)]
 26. Xiao, K., **Shen, Y.** & Huang, X. An analytical model for membrane fouling evolution associated with gel layer growth during constant pressure stirred dead-end filtration. *J. Membr. Sci.* 427, 139-149 (2013). [[link](#)]
 27. Kumar, M., **Shen, Y.** & Saboe P. Biological and biomimetic membranes. In *Encyclopedia of Membrane Science and Technology*, Eds. V. Tarabara and E. Hoek, Wiley Interscience. [[link](#)]
 28. Mo, Y., Xiao, K., **Shen, Y.** & Huang, X. A new perspective on the effect of complexation between calcium and alginate on fouling during nanofiltration. *Sep. Purif. Technol.* 82, 121-127 (2011). [[link](#)]
 29. Huang, X., Xiao, K. & **Shen, Y.** Recent advances in membrane bioreactor technology for wastewater treatment in China. *Front. Environ. Sci. Eng. China* 4, 245-271 (2010). [[link](#)]
 30. Zhao, W., **Shen, Y.**, Xiao, K. & Huang, X. Fouling characteristics in a membrane bioreactor coupled with anaerobic–anoxic–oxic process for coke wastewater treatment. *Bioresour. Technol.* 101, 3876-3883 (2010). [[link](#)]
 31. Zhao, W., Huang, X., Lee, D., Wang, X. & **Shen, Y.** Use of submerged anaerobic–anoxic–oxic membrane bioreactor to treat highly toxic coke wastewater with complete sludge retention. *J. Membr. Sci.* 330, 57-64 (2009). [[link](#)]

INVITED PRESENTATIONS

1. **Shen, Y.**, Ren, T. & Kumar, M. Highly permeable artificial water channels in block copolymer membranes. Membranes: Materials & Processes, Gordon Research Conference, New London, NH, August 2016 (One of the 11 student or postdoc delegates selected nationwide)
2. **Shen, Y.**, Licsandru, E., Barboiu, M. & Kumar, M. Functional reconstitution and characterization of artificial proton channels. 25th Annual North American Membrane Society Meeting, Boston, MA, June 2015. (Awards section)
3. **Shen, Y.**, Erbakan, M., Decker, K., Aksimentiev, A., Hou, J. & Kumar, M. Artificial Water Channels—Can they reach the performance of biological channels? Membranes: Materials & Processes, Gordon Research Seminar, New London, NH, July 2014.
4. **Shen, Y.**, Erbakan, M., Hou, J. & Kumar, M. Single Molecule Transport Characterization of a High Permeable Artificial Water Channel. Council for Chemical Research Annual Meeting, Alexandria, VA, May 2014. (One of the 8 student delegates selected nationwide)

CONFERENCE PRESENTATIONS AND POSTERS

1. **Shen, Y.**, Ren, T. & Kumar, M. Highly permeable artificial water channels in block copolymer membranes. 26th Annual North American Membrane Society Meeting, Bellevue, WA, May 2016. (talk and poster)
2. **Shen, Y.**, et al. Artificial Channels—Can they reach the performance of biological channels? 51st AEESP Anniversary Conference, New Haven, CT, June 2015. (poster)
3. **Shen, Y.**, et al. Artificial Channels—Can they reach the performance of biological channels? 25th Annual North American Membrane Society Meeting, Boston, MA, June 2015. (talk and poster)
4. **Shen, Y.**, Erbakan, M., Decker, K., Aksimentiev, A., Hou, J. & Kumar, M. Artificial Water Channels—Can they reach the performance of biological channels? 2014 Annual AIChE conference, Atlanta, GA, November 2014. (talk)
5. **Shen, Y.**, Erbakan, M., Decker, K., Aksimentiev, A., Hou, J. & Kumar, M. Artificial Water Channels—Can they reach the performance of biological channels? Membranes: Materials & Processes, Gordon Research Conference and Seminar, New London, NH, July 2014. (talk and poster)
6. **Shen, Y.**, Erbakan, M., Decker, K., Aksimentiev, A., Hou, J. & Kumar, M. Artificial Water Channels—Can they reach the performance of biological channels? 24th Annual North American Membrane Society Meeting, Houston, TX, July 2014. (talk and poster)
7. Feroz, H., **Shen, Y.**, Ferlez, B., Golbeck, J. & Kumar, M. Light driven ion pumps for desalination. 24th Annual North American Membrane Society Meeting, Houston, TX, July 2014. (poster)
8. **Shen, Y.**, Sines, I., Licsandru, E., Barboiu, M. & Kumar, M. Functional reconstitution and characterization of artificial water channels for desalination. 246th ACS National Meeting & Exposition, Indianapolis, IN, September 2013. (talk)
9. **Shen, Y.**, Licsandru, E., Barboiu, M. & Kumar, M. Functional reconstitution and characterization of artificial water channels for desalination. 50th AEESP Anniversary Conference, Golden, CO, July 2013. (poster)
10. **Shen, Y.**, Licsandru, E., Barboiu, M. & Kumar, M. Functional reconstitution and characterization of artificial water channels for desalination. 23rd Annual North American Membrane Society Meeting, Boise, ID, July 2013. (poster)
11. Feroz, H., **Shen, Y.**, Ferlez, B., Golbeck, J. & Kumar, M. Light driven desalination membranes. 23rd Annual North American Membrane Society Meeting, Boise, ID, July 2013. (poster)

12. **Shen, Y.**, Edwards, A., Saboe, P., Erbakan, M. & Kumar, M. Supported lipid-aquaporin-crystal based biomimetic membranes for desalination. Membranes: Materials & Processes, Gordon Research Conference and Seminar, New London, NH, August 2012. (poster)
13. **Shen, Y.**, Xiao, K., Liang, P., Sun, J., Sai, S. & Huang, X. Soluble microbial products in 10 large-scale membrane bioreactors for municipal wastewater treatment in China: Physiochemical properties and fouling propensity. 6th IWA Conference on Membranes for Water and Wastewater Treatment, Aachen, Germany, September 2011. (talk)
14. **Shen, Y.**, Ma, Y., Liang, P. & Huang, X. Improvement on Modified Lowry Methods against interference by divalent cations for soluble protein quantitation in wastewater systems. 3rd IWA Asia Pacific Young Water Professionals Conference, Singapore, November 2010. (talk)
15. **Shen, Y.**, Zhao, W. & Huang, X. Fouling characteristics in a membrane bioreactor coupled with anaerobic-anoxic-oxic process for coke wastewater treatment. 2nd Forum of Membrane Technology for University Graduates Jing-Jin-Tang District. Beijing, China, October 2009. (talk)
16. **Shen, Y.**, Zhao, W., Xiao, K. & Huang, X. A new insight into fouling propensity of soluble microbial products in membrane bioreactors based on hydrophobic interaction and size exclusion. 5th IWA Conference on Membranes for Water and Wastewater Treatment. Beijing, China, September 2009. (talk)

PROPOSAL WRITING EXPERIENCE (involved in preliminary data collection, writing and figure preparation)

1. Kumar, M. (Principal Investigator). "Army ERDC: Channel based membranes for energy efficient desalination and water reuse." Total requested: \$300,000.00. (submitted: Feb 20, 2016, funded). Wrote the first few drafts and made all the figures. Was highly appreciated by reviewers for visual content.
2. Kumar, M. (Principal Investigator), "GOALI Collaborative Research: Nanoporous block copolymer films as support for two-dimensional crystal based biomimetic membranes," National Science Foundation. Total awarded: \$194,000.00. (submitted: 2014, funded: August 1, 2015 - July 31, 2018).
3. Kumar, M. (Principal Investigator), Sponsored Research, "Collaborative Research: A Multi-Tiered Approach to Generating Increased Carbon Dioxide for Photosynthesis," National Science Foundation. Total requested: \$394,853.00. (submitted: 2014, funded: March 2014 - February 2017).
4. Kumar, M. (Principal Investigator), Grant, "Collaborative development of membrane protein based water treatment membranes using PDMS-PMOXA block copolymer vesicles and crystals," Applied Biomimetic (previously AquaZ A/S), Cincinnati Ohio. Total awarded: \$150,727.00. (submitted: 2013, funded: December 1, 2013 - May 31, 2014).
5. Kumar, M. (Principal Investigator), Contract, "Testing of new generation of RO pretreatment membranes," PPG Industries. Total requested: \$46,314.00. Total awarded: \$46,314.00. (submitted: April 22, 2012, funded: June 1, 2012 - October 31, 2012).
6. Kumar, M. (Principal Investigator), "CAREER: Bioinspired Artificial Channel Water Treatment Membranes," National Science Foundation. Total requested: \$500,000.00. (submitted: July 22, 2015, funded).
7. Kumar, M. (Principal Investigator), Grant, "Bioinspired Artificial Water Channels for Energy Efficient Separations," Department of Energy. Total requested: \$750,000.00. (submitted: 2014, not funded).
8. Kumar, M. (Principal Investigator), "CAREER: Polymer - Membrane Protein crystals: novel materials for energy and environmental applications and interdisciplinary education," National Science Foundation, Total requested: \$450,000.00. Total awarded: \$0.00. (submitted: July 24, 2012, not funded).

TEACHING AND MENTORSHIP ACTIVITIES

1. Co-instructor of ChE 210 class, Introduction to Material Balances, Fall 2016
2. Graduate Online Teaching Certificate, Penn State, 2015
3. Volunteered to teach several chemical engineering courses during my Ph.D. In the ChE 480 class, I was the co-lecturer and selected as the Teaching Fellow of the department. I was responsible for preparing course materials, project design, giving lectures and grading.
 - o ChE 449, Bioseparations, Spring 2013
 - o ChE 480, Unit Operation of Chemical Engineering, Spring 2014
 - o ChE 330, Fluid Mechanics, Fall 2015
4. Teaching assistant for two chemical engineering courses. I was responsible for onsite experiments demonstration, office hours and exam grading.
 - o ChE 480, Unit Operation of Chemical Engineering, Fall 2013
 - o ChE 330, Fluid Mechanics, Fall 2015
5. Mentor and Volunteer, Science U H₂uOH! Water Camp at Penn State (2013 to present). At this camp, I was responsible for organizing the trip to wastewater treatment plant, demonstrating wastewater treatment experiments and helping middle school students to design hands-on experiments.

PROFESSIONAL MEMBERSHIPS, SERVICE AND ACTIVITIES

1. Visiting scholar at Department of Chemistry, Fudan University, March to April, 2015
2. AIChE member, 2013-present
3. North American Membrane Society member, 2013-present