

Rohit N. Karnik

Associate Professor
Department of Mechanical Engineering
Massachusetts Institute of Technology

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Education

University of California, Berkeley	Ph.D. in Mechanical Engineering	2006
<i>Ph.D. Thesis – Manipulation and Sensing of Ions and Molecules in Nanofluidic Devices</i> Advisor: Prof. Arun Majumdar		
University of California, Berkeley	M.S. in Mechanical Engineering	2004
<i>M. S. Thesis – A Microfluidic Platform for the Study of Millisecond Biochemical Kinetics in Crowded Solutions</i> Advisor: Prof. Arun Majumdar		
Indian Institute of Technology, Bombay	B. Tech. in Mechanical Engineering	2002
<i>B. Tech. Thesis – Finite Element Analysis of 3D Cracks</i> Advisor: Prof. S. K. Maiti		

Experience

Massachusetts Institute of Technology	Undergraduate Officer	July 2016 – present
Massachusetts Institute of Technology	Associate Professor	July 2012 – present
Massachusetts Institute of Technology	D'Arbelloff Assistant Professor	July 2008 – June 2012
Massachusetts Institute of Technology	Assistant Professor	Sept. 2007 – June 2008
Massachusetts Institute of Technology	Postdoctoral Associate (Advisor: Prof. Robert Langer)	Oct. 2006 – August 2007
University of California, Berkeley	Graduate Student Researcher	Aug. 2002 – July 2006
EPFL, Lausanne	Summer Intern	June 2000 – July 2000

Awards

- National Academies Arab-American Frontiers of Science, Engineering, and Medicine Symposium (2016)
- Best Poster Award, 2016 MRS Fall Meeting, Boston MA (2016)
“Water Filtration Using Naturally-Occurring Membranes in Plant Xylem”
- Young Alumni Achiever Award, IIT Bombay (2014)
- Best Poster Award, MIT Water Night 2014
- Best Poster Award in the MEMS Division, Nanotechnology Forum, ASME Congress (2013)
“Automated Microfluidic Platform for Multiplexed Measurement of Solid-State Nanopores”
- Best Poster Award, 3rd Asia-Pacific Chemical and Biological Microfluidics Conferences (2013)
“High-throughput synthesis of polymeric nanoparticles using 3D flow focusing in parallel microchannels towards in vivo study”
- Outstanding Paper Award, ASME Global Congress on Nano Engineering for Medicine and Biology (2013)
“On-chip ultrahigh purity isolation of neutrophils from whole blood for point-of-care applications”

- Department of Energy Early Career Award (2012)
“Graphene Membranes with Tunable Nanometer-scale Pores”, Basic Energy Sciences
- Keenan Award for Innovation in Undergraduate Education (2011)
For contributions to the undergraduate Micro/Nano Engineering Laboratory course 2.674
- Grand Prize in the Nanotechnology Forum in the 2010 ASME Congress (2010)
Best poster out of 162 posters “Vapor-trapping membrane for reverse osmosis”
- National Science Foundation CAREER Award (2010)
“Cell Separation by Rolling on Asymmetric Receptor Patterns”, Chemical and Biological Separations
- D’Arbello Career Development Assistant Professor, Massachusetts Institute of Technology (2008)
- Institute Silver Medal (2002)
First position in Mechanical Engineering in IIT Bombay.
- Best Outgoing Student in Mechanical Engineering (2002)
Best extracurricular and academic performance in Mechanical Engineering, IIT Bombay.
- Subramaniam Award (2001)
Academic excellence in the Mechanical Engineering class till the junior year, IIT Bombay.
- National Talent Search Scholarship, Government of India (1996).

Research Highlights

Massachusetts Institute of Technology (2007 – present)

Assistant/Associate Professor of Mechanical Engineering

Collaboration: Dr. Robert Langer (MIT), Dr. Jeff Karp (HST Center MIT & Harvard), Dr. Krystyn van Vliet (MIT), Dr. Nicolas Hadjiconstantinou (MIT), Dr. Carlos Aguilar (Lincoln Labs), Dr. Omid Farokhzad (Brigham and Women’s Hospital, Harvard medical school), Dr. Patricia Hibberd (Tufts Medical School and Massachusetts General Hospital), Dr. Angela Belcher (MIT), Dr. Jing Kong (MIT), Dr. Tahar Laoui (KFUPM), Dr. John Hart (MIT), Dr. Chintan Vaishnav (MIT).

- Cell separation and analysis
 - Developed a new method to separate cells based on rolling and hydrodynamic interactions with 3D obstacles in continuous flow with a throughput of 10^6 cells/h using parallel channels. This work featured on the cover of *Lab on a Chip*.
 - Developed a new technique for label-free cell separation by cell rolling on asymmetrically patterned receptors, and demonstrated direct isolation of neutrophils from whole blood with high purity and leukocyte enrichment ratios of 500,000x that are unprecedented for any continuous cell sorting method.
 - Created a new model for cell rolling that incorporated the effects of cortical tension of the cell.
 - Quantified cell rolling behavior on asymmetric patterns and demonstrated the random nature of cell detachment events.
 - Developed a “cell adhesion cytometer” to assess phenotypes of mesenchymal stem cells.
 - Developed a microfluidic circuit for self-sorting of soft particles based on hydrodynamic resistance induced in a channel.
- Nanostructured Membranes
 - Proposed a concept of vapor-trapping reverse osmosis membranes for desalination of water and showed its potential for high flux and lower viscous loss using modeling.
 - Created membranes incorporating short hydrophobic pores to implement the concept of vapor trapping membranes and elucidated the basic molecular mechanisms governing flow.
 - Developed a method to create single-layer graphene membranes with nanometer-scale holes on a porous support for filtration.
 - Demonstrated for the first time, selective transport of molecules through macroscopic graphene membranes.
 - Demonstrated tunable transport across graphene membranes with controllable, high-density, sub-nanometer pores.
 - Demonstrated use of plant xylem for low-cost water filtration.
- Microfluidic synthesis of polymeric nanoparticles
 - Developed a coaxial jet mixer for controlled synthesis of polymeric nanoparticles.

- Synthesized hybrid lipid-polymer nanoparticles for cancer therapy in a single step with control over their properties using microfluidic mixing.
- Developed microfluidic devices for controlled, high-throughput synthesis of polymeric nanoparticles for cancer therapy.
- Created microfluidic devices with 3D flow focusing for isolating precipitating polymers from channel walls for robust nanoprecipitation.
- Used microfluidic synthesis to prepare and screen nanoparticles loaded with irinotecan and cisplatin for combination drug therapy.
- Studied the effects of ligand solubility on self-assembly of polymeric nanoparticles and showed that hydrophobic ligands tend to be buried inside the nanoparticle.
- Nanofluidic single molecule sensing
 - Developed a nanopore device for active feedback control of single DNA molecules, which enabled >100 resistive-pulse measurements per molecule for more accurate sizing.
 - Developed a membrane transfer process to integrate nanopores drilled in free-standing membranes of TEM grids into microfluidic devices to potentially enable operations such as single molecule sorting.

Massachusetts Institute of Technology (2006 - 2007)

Postdoctoral Associate

Advisor: Prof. Robert Langer

Collaboration: Dr. Jeff Karp and Dr. Omid Farokhzad, Brigham and Women's Hospital, Harvard medical school.

- Created for the first time, microfluidic devices for controlled synthesis of polymeric nanoparticles using nanoprecipitation for drug delivery applications.
- Invented a new method for controlling the transport of cells using transient adhesions on asymmetrically patterned receptors.

University of California, Berkeley (2002 - 2006)

Graduate Student Researcher

Advisor: Prof. Arun Majumdar, Department of Mechanical Engineering

Collaboration: Prof. Peidong Yang, Department of Chemistry and Prof. Jamie Doudna-Cate, Departments of Molecular and Cell Biology and Chemistry

- Developed nanofluidic transistors and demonstrated for the first time field-effect control of ions and biomolecules. This work received news coverage in the *Scientific American*.
- Studied the competing effects of charge and size of proteins immobilized in nanofluidic channels.
- Developed a unique diffusion-controlled molecular patterning technique in nanofluidic channels that allows for non-invasive patterning of molecules.
- Created a two-phase microfluidic mixer to mix highly concentrated protein solutions under conditions emulating those *in vivo* and studied the effect of proteins at interfaces on mixing in droplet systems.
- Invented a room-temperature transfer-bonding technique using PDMS for bonding surfaces with uneven topography and temperature-sensitive materials.
- Worked on integration of Ag/AgCl electrodes with microfluidic channels for spatial control of electrokinetic phenomena in microfluidics.
- Created a nanofluidic diode for rectification of transport and concentration control of ions, covered by *Nature Nanotechnology*.

Indian Institute of Technology, Bombay (2001 - 2002)

Undergraduate Student

Advisor: Prof. S. K. Maiti

- Developed a family of stress-continuous finite elements for modeling stress singularities.
- Presented an undergraduate seminar on fracture mechanism of short cracks.

Internship at EPFL, Lausanne (Summer, 2000)

- Programmed a Java application to interactively display aerofoil flows on the internet.

Journal Publications

1. R. Karnik, R. Fan, M. Yue, D. Li, P. Yang and A. Majumdar. Electrostatic control of ions and molecules in nanofluidic transistors. *Nano Letters* 5, 943-948 (2005).
2. R. Karnik, K. Castelino, R. Fan, P. Yang and A. Majumdar. Effects of biological reactions and modifications on conductance of nanofluidic channels. *Nano Letters* 5, 1638-1642 (2005).
3. A. Liao, R. Karnik, A. Majumdar and J. Doudna-Cate. Mixing biological crowded solutions in milliseconds. *Analytical Chemistry* 77, 7618-7625 (2005).
4. S. Satyanarayana, R. Karnik and A. Majumdar. Stamp-and-stick room-temperature bonding technique for microdevices. *Journal of Microelectromechanical Systems* 14, 392-399 (2005).
5. R. Fan, R. Karnik, M. Yue, D. Li, A. Majumdar and P. Yang. DNA translocation in inorganic nanotubes. *Nano Letters* 5, 1633-1637 (2005).
6. K. Dunphy, R. Karnik, C. Trinkle and A. Majumdar. Analysis of governing parameters of silver-silver chloride electrodes in microfluidic electrokinetic devices. *Microscale Thermophysical Engineering* 9, 199-211 (2005).
7. R. Fan, M. Yue, R. Karnik, D. Li, A. Majumdar and P. Yang. Polarity switching and transient responses in single nanotube nanofluidic transistors. *Physical Review Letters* 95, Art. No. 086607 (2005).
8. R. Karnik, K. Castelino, C. Duan and A. Majumdar. Diffusion-limited patterning of molecules in nanofluidic channels. *Nano Letters* 6, (2006).
9. R. Karnik, K. Castelino and A. Majumdar. Field-effect control of protein transport in a nanofluidic transistor circuit. *Applied Physics Letters* 88, 123114 (2006).
10. K. Dunphy, R. Karnik, J. Newman and A. Majumdar. Spatially controlled microfluidics using low-voltage electrokinetics. *Journal of Microelectromechanical Systems*, 15, 237-245 (2006).
11. M-C Lu, S. Satyanarayana, R. Karnik, A. Majumdar and C-C Wang. Mechanical-electrokinetic battery by using a nano-porous membrane. *Journal of Micromechanics and Microengineering* 16, 667-675 (2006).
12. R. Karnik, C. Duan, K. Castelino, A. Majumdar. Rectification of ionic transport in a nanofluidic diode. *Nano Letters* 7, 547-551 (2007).
13. F. Gu, R. Karnik, et al. Targeted nanoparticles for cancer therapy. *Nano Today* 2, 14-21 (2007).
14. R. Karnik, S. Hong, H. Zhang, Y. Mei, D. Anderson, J. M. Karp, and R. Langer. Nanomechanical control of cell rolling in two dimensions through surface patterning of receptors. *Nano Letters* 8, 1153-1158 (2008).
15. R. Karnik, F. Gu, P. Basto, C. Cannizzaro, L. Dean, W. Kyei-Manu, R. Langer, and O. C. Farokhzad. Microfluidic platform for controlled synthesis of polymeric nanoparticles *Nano Letters* 8, 2906-2912 (2008).
16. D. Sarkar, P. K. Vemula, G. S. L. Teo, D. Spelke, R. Karnik, L. Y. Wee, and J. M. Karp. Cell surface conjugation of sialyl Lewis X induces a rolling response for human mesenchymal stem cells. *Bioconjugate Chemistry* 19, 2105-2109 (2008).
17. Y-H. Sen and R. Karnik. Investigating the translocation of λ -DNA molecules through PDMS nanopores. *Analytical and Bioanalytical Chemistry* 394, 437-446 (2009).
18. P. M. Valencia, P. A. Basto, L. Zhang, M. Rhee, R. Langer, O. C. Farokhzad, and R. Karnik. Single-step assembly of homogenous lipid-polymeric and lipid-quantum dot nanoparticles enabled by microfluidic rapid mixing. *ACS Nano* 4, 1671-1679 (2010).
19. D. Sarkar, P. K. Vemula, W. Zhao, A. Gupta, R. Karnik, and J. M. Karp. Engineered mesenchymal stem cells with self-assembled vesicles for systemic cell targeting. *Biomaterials* 31, 5266-5274 (2010).
20. J. Lee and R. Karnik. Desalination of water by vapor-phase transport through hydrophobic nanopores. *Journal of Applied Physics* 108, 044315 (2010).
21. N. Kolishetti, S. Dhar, P. M. Valencia, L. Q. Lin, R. Karnik, S. J. Lippard, R. Langer, and O. C. Farokhzad. Engineering of self-assembled nanoparticle platform for precisely controlled combination drug therapy. *Proc. Natl. Acad. Sci. (USA)* 107, 17939-17944 (2010).
22. S. Bose, S. K. Das, J. M. Karp, and R. Karnik. A semi-analytical model to study the effect of cortical tension on cell rolling. *Biophysical Journal* 99, 3870-3879 (2010).

23. C. Lee, S. Bose, K. J. Van Vliet, J. M. Karp, and **R. Karnik**. Examining lateral displacement of HL60 cells rolling on asymmetric P-selectin patterns. *Langmuir* 27, 240-249 (2011).
24. C. Lee, S. Bose, K. J. Van Vliet, J. M. Karp, and **R. Karnik**. Studying cell rolling trajectories on asymmetric receptor patterns. *Journal of Visualized Experiments* 48, (2011).
25. M. Rhee, P. M. Valencia, M. I. Rodriguez, R. Langer, O. C. Farokhzad, and **R. Karnik**. Synthesis of size-tunable polymeric nanoparticles enabled by 3D hydrodynamic flow focusing in single-layer microchannels. *Advanced Materials* 23, H79-H83 (2011). *Frontispiece Article*
26. W. Zhao, S. Schafer, J. Choi, Y. J. Yamanaka, M. L. Lombardi, S. Bose, A. L. Carlson, J. A. Phillips, W. Teo, I. A. Droujinine, C. Cui, R. K. Jain, J. Lammerding, J. C. Love, C. P. Lin, D. Sarkar, **R. Karnik**, and J. M. Karp. Cell-surface sensors for real-time probing of cellular nanoenvironments. *Nature Nanotechnology* 6, 524-531 (2011).
27. T. Humplik, J. Lee, S. C. O'Hern, B. A. Fellman, M. A. Baig, S. F. Hassan, M. A. Atieh, F. Rahman, T. Laoui, **R. Karnik**, and E. N. Wang. Nanostructured materials for water desalination. *Nanotechnology* 22, 292001 (2011).
28. P. M. Valencia, M. H. Hanewich-Hollatz, W. Gao, F. Karim, R. Langer, **R. Karnik**, and O. C. Farokhzad. Effects of Ligands with Different Water Solubilities on Self-Assembly and Properties of Targeted Nanoparticles. *Biomaterials* 32, 6226-6233 (2011).
29. W. Zhao, W. Loh, I. A. Droujinine, W. Teo, N. Kumar, S. Schafer, C. H. Cui, L. Zhang, D. Sarkar, **R. Karnik**, and J. M. Karp. Mimicking the Inflammatory Cell Adhesion Cascade by Nucleic Acid Aptamer Programmed Cell-Cell Interactions. *The FASEB Journal* 25, 3045-3056 (2011).
30. D. Sarkar, J. A. Spencer, J. A. Phillips, W. Zhao, S. Schafer, D. P. Spelke, L. J. Mortensen, J. P. Ruiz, P. K. Vemula, R. Sridharan, S. Kumar, **R. Karnik**, C. P. Lin, and J. M. Karp. Engineered Cell Homing. *Blood* 118, e184-e191 (2011).
31. Y.-H. Sen, T. Jain, C. A. Aguilar, and **R. Karnik**. Enhanced Discrimination of DNA Molecules in Nanofluidic Channels Through Multiple Measurements. *Lab on a Chip* 12, 1094-1101 (2012).
32. M. A. Cartas-Ayala, and **R. Karnik**. Local Temperature Profile Measurement in Microchannels Using Temperature Sensitive Leuco-Dye Microbeads. *International Journal of Micro-Nano Scale Transport* 2, 41-56 (2012).
33. S. Choi, J. M. Karp, and **R. Karnik**. Cell Separation by Deterministic Cell Rolling. *Lab on a Chip* 12, 1427-1430 (2012). *Front Cover Article*
34. C. Duan, **R. Karnik**, M. Lu and A. Majumdar. Evaporation-induced Cavitation in Nanofluidic Channels. *Proc. Natl. Acad. Sci. (USA)* 109, 3688-3693 (2012).
35. J. Lee, F. Rahman, T. Laoui, and **R. Karnik**. Bubble-induced Damping in Displacement-driven Microfluidic Flows. *Physical Review E* 86, 026301 (2012).
36. E. N. Wang and **R. Karnik**. Water Desalination: Graphene Cleans up Water. *Nature Nanotechnology* 7, 552-554 (2012). (*News & Views Article*)
37. P. M. Valencia, O. C. Farokhzad, **R. Karnik**, and R. Langer. Microfluidic Technologies for Accelerating the Clinical Translation of Nanoparticles. *Nature Nanotechnology* 7, 623-629 (2012).
38. S. C. O'Hern, C. A. Stewart, M. S. H. Boutilier, J.-C. Idrobo, S. Bhaviripudi, S. K. Das, J. Kong, T. Laoui, M. Atieh, and **R. Karnik**. Selective Molecular Transport through Intrinsic Defects in a Single Layer of CVD Graphene. *ACS Nano* 6, 10130-10138 (2012).
39. W. Zhao, C. H. Cui, S. Bose, D. Guo, C. Shen, W. P. Wong, K. Halvorsen, O. C. Farokhzad, G. S. L. Teo, J. Phillips, D. M. Dorfman, **R. Karnik**, and J. M. Karp. A Bioinspired Multivalent DNA Network for Capture and Release of Cells. *Proc. Natl. Acad. Sci. (USA)* 109, 19626-19631 (2012).
40. W. K. Cho, J. A. Ankrum, D. Guo, S. A. Chester, S. Y. Yang, A. Kashyap, G. A. Campbell, R. J. Wood, R. K. Rijal, **R. Karnik**, R. Langer, and J. M. Karp. Microstructured Barbs on the North American Porcupine Quill Enable Easy Tissue Penetration and Difficult Removal. *Proc. Natl. Acad. Sci. (USA)* 109, 21289-21294 (2012).
41. M. A. Cartas-Ayala, M. Raafat, and **R. Karnik**. Self-sorting of Deformable Particles in an Asynchronous Logic Microfluidic Circuit. *Small* 9, 375-381 (2013). *Front Cover Article*
42. C. Salvador-Morales, P. M. Valencia, W. Gao, **R. Karnik**, and O. C. Farokhzad. Spontaneous Formation of Heterogeneous Patches on Polymer-lipid Core-shell Particle Surfaces during Self-assembly. *Small* 9, 511-517 (2013).

43. T. Jain, R. S. Guerrero, C. A. Aguilar, and **R. Karnik**. Integration of Solid-State Nanopores in Microfluidic Networks via Transfer Printing of Suspended Membranes. *Analytical Chemistry* 85, 3871-3878 (2013).
44. P. M. Valencia, E. M. Pridgen, B. Perea, S. Gadde, C. Sweeney, P. W. Kantoff, S. J. Lippard, R. Langer, **R. Karnik**, and O. C. Farokhzad. Synergistic Cytotoxicity of Irinotecan and Cisplatin in Dual-Drug PSMA-Targeted Polymeric Nanoparticles. *Nanomedicine* 8, 687-698 (2013).
45. H. Y. Yang, Z. J. Han, S. F. Yu, K. L. Pey, K. Ostrikov, and **R. Karnik**. Carbon Nanotube Membranes with Ultrahigh Specific Adsorption Capacity for Water Desalination and Purification. *Nature Communications* 4, 2220 (2013).
46. S. Bose, R. Singh, M. Hanewich-Hollatz, C. Shen, C.-H. Lee, D. M. Dorfman, J. M. Karp, and **R. Karnik**. Affinity Flow Fractionation of Cells via Transient Interactions with Asymmetric Molecular Patterns. *Scientific Reports* 3, 2329 (2013).
47. E. M. Pridgen, F. Alexis, T. T. Kuo, E. Levy-Nissenbaum, **R. Karnik**, R. S. Blumberg, R. Langer, and O. C. Farokhzad. Transepithelial Transport of Fc-Targeted Nanoparticles by the Neonatal Fc Receptor for Oral Delivery. *Science Translational Medicine* 5, 213ra167 (2013).
48. P. M. Valencia, E. M. Pridgen, M. Rhee, R. Langer, O. C. Farokhzad, and **R. Karnik**. Microfluidic Platform for Combinatorial Synthesis and Optimization of Targeted Nanoparticles for Cancer Therapy. *ACS Nano* 7, 10671-10680 (2013).
49. O. Levy, P. Anandakumaran, J. Ngai, **R. Karnik**, and J. M. Karp. Systematic Analysis of In Vitro Cell Rolling Using a Multi-Well Plate Microfluidic System. *Journal of Visualized Experiments*, 80, (2013).
50. S. Choi, O. Levy, M. B. Coelho, J. M. S. Cabral, J. M. Karp, and **R. Karnik**. A Cell Rolling Cytometer Reveals the Correlation between Mesenchymal Stem Cell Dynamic Adhesion and Differentiation State. *Lab on a Chip* 14, 161-166 (2014). *Inside Cover Article, Selected as Hot Article*
51. J. M. Lim, N. Bertrand, P. M. Valencia, M. Rhee, R. Langer, S. Jon, O. C. Farokhzad, and **R. Karnik**. Parallel Microfluidic Synthesis of Size-tunable Polymeric Nanoparticles Using 3D Flow Focusing towards *in Vivo* Study. *Nanomedicine: Nanotechnology, Biology, and Medicine* 10, 401-409 (2014).
52. M. A. Cartas-Ayala, L. Gilson, C. Shen, and **R. Karnik**. Oscillations in Light-triggered Logic Microfluidic Circuit. *Microsystem Technologies* 20, 437-444 (2014).
53. C. Sun, M. S. H. Boutilier, H. Au, P. Poesio, B. Bai, **R. Karnik**, and N. G. Hadjiconstantinou. Mechanisms of Molecular Permeation through Nanoporous Graphene Membranes. *Langmuir* 30, 675-682 (2014).
54. M. S. H. Boutilier, C. Sun, S. C. O'Hern, H. Au, N. G. Hadjiconstantinou, and **R. Karnik**. Implications of Permeation through Intrinsic Defects in Graphene on the Design of Defect-Tolerant Membranes for Gas Separation. *ACS Nano* 8, 841-849 (2014).
55. M. A. Cartas-Ayala and **R. Karnik**. Time Limitations and Geometrical Parameters in the Design of Microfluidic Comparators. *Microfluidics and Nanofluidics* 17, 359-373 (2014).
56. J. Lee, T. Laoui, and **R. Karnik**. Nanofluidic Transport Governed by the Liquid/Vapour Interface. *Nature Nanotechnology* 9, 317-323 (2014).
57. M. S. H. Boutilier, J. Lee, V. Chambers, V. Venkatesh, and **R. Karnik**. Water Filtration Using Plant Xylem. *PLOS ONE* 9, e89934 (2014).
58. T. Jain, M. Aernecke, V. Liberman, and **R. Karnik**. High Resolution Fabrication of Nanostructures using Controlled Proximity Nanostencil Lithography. *Applied Physics Letters* 104, 083117 (2014).
59. S. C. O'Hern, M. S. H. Boutilier, J. C. Idrobo, Y. Song, J. Kong, T. Laoui, M. A. Atieh, and **R. Karnik**. Selective Ionic Transport through Tunable Sub-Nanometer Pores in Single-Layer Graphene Membranes. *Nano Letters* 14, 1234-1241 (2014).
60. J. M. Lim, A. Swami, L. M. Gilson, S. Chopra, S. Choi, J. Wu, R. Langer, **R. Karnik**, and O. C. Farokhzad. Ultra-high Throughput Synthesis of Nanoparticles with Homogeneous Size Distribution Using a Coaxial Turbulent Jet Mixer. *ACS Nano* 8, 6056-6065 (2014).
61. **R. N. Karnik**. Breakthrough for Protons. *Nature* 516, 173-175 (2014). (*News & Views Article*)
62. A. Ibrahim, S. Akhtar, M. Atieh, **R. Karnik**, and T. Laoui. Effects of Annealing on Copper Substrate Surface Morphology and Graphene Growth by Chemical Vapor Deposition. *Carbon* 94, 369-377 (2015).

63. T. Jain, B. C. Rasera, R. J. S. Guerrero, M. S. H. Boutilier, S. C. O'Hern, J.-C. Idrobo, and **R. Karnik**. Heterogeneous Sub-Continuum Ionic Transport in Statistically Isolated Graphene Nanopores. *Nature Nanotechnology* 10, 1053-1057 (2015).
64. X. Zhu, J. Wu, W. Shan, W. Tao, L. Zhao, J. M. Lim, M. D'Ortenzio, **R. Karnik**, Y. Huang, J. Shi, and O. C. Farokhzad. Polymeric Nanoparticles Amenable to Simultaneous Installation of Exterior Targeting and Interior Therapeutic Proteins. *Angewandte Chemie* 55, 3309-3312 (2016).
65. F. M. Kafiah, Z. Khan, A. Ibrahim, **R. Karnik**, M. Atieh, and T. Laoui. Monolayer Graphene Transfer onto Polypropylene and Polyvinylidenedifluoride Microfiltration Membranes for Water Desalination. *Desalination* 388, 29-37 (2016).
66. M. S. H. Boutilier, R. Ramakrishnan, H. Al-Qahtani, and **R. Karnik**. A Micro/Nano Engineering Laboratory Module on Superoleophobic Membranes for Oil-Water Separation. *Journal of Materials Education* 38, 75-92 (2016).

Proceedings of Refereed Conferences

1. Karnik, R., Castelino, K., Duan, C., Fan, R., Yang, P. and Majumdar, A., "Nanofluidic Devices for Sensing and Flow Control," Proceedings of ASME 4th International Conference on Nanochannels, Microchannels, and Minichannels, Limerick, Ireland, June 2006.
2. Karnik, R., Duan, C., Castelino, K., Fan, R., Yang, P. and Majumdar, A., "Transport of Ions and Molecules in Nanofluidic Devices," Proceedings of the 6th International ASME Conference on Nanochannels, Microchannels, and Minichannels, Darmstadt, Germany, June 2008.
3. Bose, S., Hong, S., Langer, R., Karp, J. M., and Karnik, R., "Microfluidic Patterning of P-selectin for Cell Separation through Rolling," Proceedings of the 12th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Diego, CA, October 2008.
4. Sen, Y-H., and Karnik, R., "Multiple Measurements on the Same Molecule in a Nanopore System with Feedback Control, Proceedings of the 12th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Diego, CA, October 2008.
5. Valencia, P., Basto, P., Gu, F., Zhang, L., Cannizzaro, C., Langer, R., Farokhzad, O. and Karnik, R., "Novel Synthesis of Polymeric Nanoparticles for Drug Delivery Applications Using Microfluidic Rapid Mixing," Proceedings of the 12th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Diego, CA, October 2008.
6. Sen, Y-H., and Karnik, R., "Multiple Measurements on the Same Molecule in a Nanopore System with Feedback Control, Proceedings of the 13th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Jeju, South Korea, November 2009.
7. Valencia, P., Basto, P., Zhang, L., Langer, R., Farokhzad, O. and Karnik, R., "Single Step Synthesis of Hybrid Lipid Nanoparticles For Drug Delivery and Imaging Applications Using Microfluidic Rapid Mixing," Proceedings of the 13th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Jeju, South Korea, November 2009.
8. Lee, C-H., Bose, S., Karp, J. M., and Karnik, R., "Controlling the Transport of Rolling Cells Through Microcontact Printing of Receptors," Proceedings of the 13th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Jeju, South Korea, November 2009.
9. Lee, J., and Karnik, R., "Vapor Trapping Membrane for Reverse Osmosis," Proceedings of the 13th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Jeju, South Korea, November 2009.
10. Rhee, M., Valencia, P. M., Rodriguez, M. I., Langer, R. S., Farokhzad O. C., and Karnik, R., "3D Hydrodynamic Focusing for Confined Precipitation of Nanoparticles within Microfluidic Channels," Proceedings of the 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Groningen, The Netherlands, October 2010.
11. Lee, C-H., Bose, S., Van Vliet, K. J., Karp, J. M., and Karnik, R., "Examining Lateral Displacement of Cells Rolling on Asymmetric Receptor Patterns," Proceedings of the 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Groningen, The Netherlands, October 2010.
12. Bose, S., Lee, C-H., Karp, J. M., and Karnik, R., "Microfluidic Devices for Rapid Label-Free Separation and Sensing of Cells," Proceedings of the 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Groningen, The Netherlands, October 2010.

13. Valencia, P. M., Rhee, M., Langer, R., Farokhzad, O. C., and Karnik, R., "Merging 'Micro' with 'Nano': On-Chip High-Throughput Synthesis of Polymeric Nanoparticles for Cancer Therapy," Proceedings of the 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Groningen, The Netherlands, October 2010.
14. Raafat, M. S., Cartas Ayala, M., and Karnik, R., "Self-sorting of Deformable Particles in a Microfluidic Circuit," Proceedings of the 14th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Groningen, The Netherlands, October 2010.
15. Lee, J., O'Hern, S. C., Karnik, R., and Laoui, T., "Vapor-Trapping Membrane for Reverse Osmosis," Proceedings of the ASME 2010 International Mechanical Engineering Congress & Exposition, Vancouver, British Columbia, Canada, November 2010. (*Winner of the Grand Prize in the best poster competition in the Micro/Nano Technology Forum, out of a total of 162 posters*).
16. Laoui, T., Hassan, S. F., Karnik, R., Wang, E., Al-Hooshani, K., Rahman, F., Atieh, M. A., Humplik, T., Lee, J., Fellman, B., O'Hern, S., Baig, M. A., and Patel, F., "Nanostructured Membranes for Water Desalination," Proceedings of the 7th International Membrane Science and Technology Conference, Sydney, Australia, November 2010.
17. Bose, S., Hanewich-Hollatz, M., Lee, C-H., Karp, J. M., and Karnik, R., "Microfluidic Devices for Rapid Label-Free Separation of Cells," Proceedings of the 15th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Seattle, WA, October 2011.
18. Choi, S., Karp, J. M., and Karnik, R., "Continuous Cell Sorting by Deterministic Cell Rolling," Proceedings of the 15th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Seattle, WA, October 2011.
19. Sen, Y-H., and Karnik, R., "Dynamic Bidirectional Conductance Modulation during DNA Translocation in a Nanofluidic Channel," Proceedings of the 25th IEEE International Conference on Micro Electro Mechanical Systems, Paris, France, January 2012.
20. Lim, J-M., Valencia, P. M., Rhee, M., Langer, R., Farokhzad, O. C., and Karnik, R., "3d Focusing in Parallel Microchannels for High-Throughput Synthesis of Polymeric Nanoparticles," Proceedings of the Solid-State Sensors, Actuators, and Microsystems Workshop, Hilton Head Island, SC, June 2012.
21. Bose, S., Hollatz, M-H., Lee, C-H., Karp, J. M., and Karnik, R., "Microfluidic Devices for Rapid Label-Free Separation of Cells and Point-Of-Care Diagnostics," Proceedings of the Solid-State Sensors, Actuators, and Microsystems Workshop, Hilton Head Island, SC, June 2012.
22. Comeau, B., Karnik, R., and Kim, S-G., "Development and Growth of an Undergraduate Micro/Nano Engineering Laboratory Course," Proceedings of the 119th American Society of Engineering Education Annual Conference and Exposition, San Antonio, TX, June 2012.
23. Bose, S., Singh, R., Hanewich-Hollatz, M., Lee, C-H., Karp, J. M., and Karnik, R., "Single-Step Ultrahigh Enrichment of Leukocytes from Whole Blood Enabled by Cell Rolling on Biomimetic Adhesive Surfaces," Proceedings of the 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Okinawa, Japan, October 2012.
24. Choi, S., Levy, O., Karp, J. M., and Karnik, R., "Cell Rolling Cytometer for Characterizing Dynamic Adhesion of Mesenchymal Stem Cells," Proceedings of the 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Okinawa, Japan, October 2012.
25. Cartas-Ayala, M. A., Gilson, L., and Karnik, R., "Size and Deformability Sorting of Particles Using Asynchronous Logic Circuits," Proceedings of the 16th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Okinawa, Japan, October 2012.
26. Cartas-Ayala, M. A., Gilson, L., Shen, C., and Karnik, R., "Forces Exerted During Cell Passage through Constrained Microfluidic Channels," Proceedings of the 3rd European Conference on Microfluidics, Heidelberg, Germany, December 2012.
27. Cartas-Ayala, M. A. and Karnik, R., "Light-Triggered Microfluidic Circuits," Proceedings of the 3rd European Conference on Microfluidics, Heidelberg, Germany, December 2012.
28. Lim, J. M., Gilson, L. M., Chopra, S., Langer, R., Farokhzad, O. C. and R. Karnik, "Coaxial Turbulent Jet Mixer for Controlled Synthesis of Nanoparticles," Proceedings of the 17th International Conference on Miniaturized Systems for Chemistry and Life Sciences, Freiburg, Germany, October 2013.

Other Publications

1. Karnik, R., "Microfluidic Mixing," in Encyclopedia of Micro- and Nano-Fluidics, Li, D. ed., Springer (2008).
2. Karnik, R. and R. S. Langer, "Building Ourselves: Ushering in an Age of Synthetic Organs and Targeted Medicine," Mechanical Engineering, 135, 34-39, February 2013.
3. Lee, J., Boutilier, M. S. H., Chambers, V., Venkatesh, V. and R. Karnik, "Water Filtration Using Plant Xylem," Arxiv, arXiv:1310.4814, October 2013.
4. Karnik, R., "Ions, Hydration, and Transport," in Transport and Reactivity of Solutions in Confined Hydrosystems, NATO Science for Peace and Security Series C: Environmental Security, Mercury, L., Tas, N. and M. Zilberbrand ed., Springer (2013).
5. Karnik, R., "Ionic and Molecular Transport through Graphene Membranes," in Transport and Reactivity of Solutions in Confined Hydrosystems, NATO Science for Peace and Security Series C: Environmental Security, Mercury, L., Tas, N. and M. Zilberbrand ed., Springer (2013).

Patents and Patent Applications

1. P. Yang, R. Karnik, K. Castelino, R. Fan, and A. Majumdar, "Functionalization of Nanofluidic Channels," PCT/US2006/26318, filed on July 2006; US 11/969,010; US8,440,453 issued on May 14, 2013.
2. A. Majumdar, R. Karnik, and W. Kim, "Nanostructured Micro Heat Pipes," PCT/US2007/019558: filed on Aug 9, 2006.
3. P. Yang, A. Majumdar, R. Fan, R. Karnik, K. Castelino, "Inorganic Nanotubes and Electrofluidic Devices Fabricated Therefrom," PCT/US2007/071265 filed on Jun 15, 2007; US 7,898,005 issued on March 1, 2011.
4. R. Karnik, F. Gu, P. Basto, C. Cannizzaro, A. Khademhosseini, R. Langer, and O. Farokhzad, "Microfluidic Synthesis of Polymeric Nanoparticles," PCT/US2007/071901: filed on Jun 22, 2007; US 9,381,477 issued on July 5, 2016.
5. R. Karnik, S. Hong, Y. Mei, D. Anderson, S. Bose, J. Karp, and R. Langer, "Cell Rolling Separation," PCT/US2008/78204, filed on Sep. 29, 2008; US12/685315; US8,986,988 issued on March 24, 2015.
6. R. Karnik, J. Lee, "Liquid Filtration Using Pressure Difference across a Hydrophobic Membrane," PCT/US2010/020625, filed on Jan 11, 2010; US 12/685,315; US 8,652,332 issued on Feb 18, 2014.
7. R. Karnik, M. Raafat, and M. Cartas Ayala, "Microfluidic Sorter for Particles, Cells, and Droplets," Provisional application No. 61388392, September 2010.
8. J. M. Karp, W. K. Cho, B. Laulicht, J. A. Ankrum, R. Karnik, and R. Langer, "Device and Uses Thereof," PCT/US2012/021778 filed on January 18, 2012; US20130331792A1.
9. S. Choi, R. Karnik, and J. M. Karp, "Cell Sorting by 3D Flow and Adhesive Rolling," PCT/US2012/58375/ US20140227777 filed on October 1, 2012.
10. R. Karnik, S. C. O'Hern, M. S. H. Boutilier, C. A. Stewart, H. Au, N. G. Hadjiconstantinou, T. Laoui, and M. A. Atieh, "Graphene Based Filter," PCT/US2013/031963/ US20130270188 filed on March 15, 2013.
11. H.-Y. Yang and R. Karnik, "Membrane for Filtrating Water," PCT/SG2013/000205 filed on May 20, 2013.
12. C. A. Aguilar, R. Karnik, T. Jain, Y-H. Sen, A. C. Schiff, J. T. Kedzierski, "Nanofluidic Sorting System for Gene Synthesis and PCR Reaction Products," PCT/US2013/63404 filed on October 4, 2013.
13. A. G. Bajpayee, A. Grodzinsky, C. R. Wong, M. G. Bawendi, and R. Karnik, "Surface Binding of Nanoparticle Based Drug Delivery to Tissue," Application No. US 14/147,863, January 2014; US 9,289,506 issued March 22, 2016.
14. J. M. Lim, L. M. Gilson, S. Chopra, O. C. Farokhzad, R. Karnik, and A. Swami, "High-Throughput Synthesis of Nanoparticles," PCT/US2014/62302, October 2014.
15. R. Karnik, S. Bose, M. S. H. Boutilier, N. G. Hadjiconstantinou, T. Jain, S. C. O'Hern, T. Laoui, and M. A. Atieh, "Mitigating Leaks in Membranes," PCT/US2014/063301, November 2014.

16. P. M. Valencia, E. M. Pridgen, S. Gadde, R. Karnik, R. S. Langer, S. J. Lippard, and O. C. Farokhzad, "Nanoparticles for Targeted Delivery of Multiple Therapeutic Agents and Methods of Use," US2014/434,300, April 8, 2015.
17. S. Chopra, R. Karnik, A. Wang, X. Zhang, O. C. Farokhzad, "Nanoparticles with pH Triggered Drug Release," Provisional Application filed October 2015.
18. R. Karnik and K. Ramchander, "Fabrication of Xylem Water Filter," US 62/269,196 Provisional Application filed December 2015.
19. E. Hanhauser, M. Bono, X. Ren, C. Vaishnav, A. J. Hart, R. Karnik, "Method for Preservation, Transport, and Analysis of Water Samples," Provisional Application filed April 2016.
20. M. Bono, S. Beasley, E. Hanhauser, C. Vaishnav, A. J. Hart, R. Karnik, "Method for Point-of-Use Testing for Bacteriological Water Contamination in Resource-Limited Environments," Provisional Application filed October 2016.
21. P. Kidambi, A. Ibrahim, T. Laoui, J. Kong, R. Karnik, "Formation of Pores in Atomically Thin Materials," US 62/418,055 Provisional Application Filed November 2016.
22. P. Kidambi, R. Karnik, D. Jang, M. S. H. Boutilier, "Techniques for Performing Diffusion Based Filtration Using Nanoporous Membranes and Related Systems and Methods," US 62/418,064 Provisional Application filed November 2016.

Invited Lectures

September 2006, "Manipulation and sensing of ions and molecules in nanofluidic devices," Department of Mechanical Engineering, Indian Institute of Technology, Mumbai, India.

April 2007, "Manipulation and Sensing of Ions and Molecules in Nanofluidic Devices," NanoNed Meeting, The Netherlands; also at Department of Physics, Delft University, The Netherlands.

October 2007, "Microfluidic Synthesis of Polymeric Nanoparticles for Targeted Drug Delivery," at Bind Biosciences Inc., Cambridge, MA.

May 2008, "Manipulation and Sensing of Ions and Molecules in Nanofluidic Devices," Nanofluidics Workshop, Joint NSLS/CFN User Meeting, Brookhaven National Laboratory, Brookhaven, NY.

June 2008, "Transport of Ions and Molecules in Nanofluidic Devices (Keynote lecture)," 6th International ASME Conference on Nanochannels, Microchannels, and Minichannels, Darmstadt, Germany.

November 2008, "Nudging Cells Using Molecular Interactions- Towards Label-free Cell Separation," Chemical and Biomolecular Engineering Department Seminar Series, University of Notre Dame, IN.

February 2009, "Label-free Sorting of Cells- Potential for Rapid Assessment of Sepsis," Workshop on Safe and Effective Instruments and Devices for Use in NICU, National Institute of Child Health and Human Development, Rockville, MD.

March 2009, "Nudging Cells Using Molecular Interactions- Towards Label-free Cell Rolling Separation," CIMIT (Center for Integration of Medicine and Innovative Technology) Forum, Massachusetts General Hospital, Boston, MA.

April 2009, "Microfluidic Systems for Detection and Analysis of Single Molecules and Particles," Northeast Bioengineering Conference (NEBEC), Boston, MA.

August 2009, "Label-Free Separation of Cells by Rolling on Patterned Receptors," The Bioprocessing Summit, Cambridge Healthtech Institute, Cambridge, MA.

December 2009, "Analysis of Single Molecules and Particles by Active Control in Nanofluidic Devices," MIT Lincoln Laboratory, Technology Office Special Seminar, Lexington, MA.

October 2010, "Analysis of Single Molecules and Particles by Active Control In Nanofluidic Devices," Joint Fall Meeting of the New England Sections of the American Physical Society and the American Association of Physics Teachers, Brown University, Providence, RI.

November 2010, "Microfluidic Devices for Direct Separation and Analysis of Cells," Clinical Pathology Conference Series, Department of Pathology, Brigham and Women's Hospital, Boston, MA.

December 2010, "Microfluidic Devices for Direct Separation and Analysis of Cells," Department of Mechanical Engineering, University of Michigan, Ann Arbor.

January 2011, "Microfluidic Devices for Direct Separation and Analysis of Cells," Singapore-MIT Alliance for Research and Technology, National University of Singapore, Singapore.

January 2011, "Microfluidic Devices for Direct Separation and Analysis of Cells," National Center for Biological Sciences, Bangalore, India.

January 2011, "Microfluidic Devices for Direct Separation and Analysis of Cells," National Center for Biological Sciences, Bangalore, India.

October, 2011, "Microfluidics for Synthesis and Development of Nanotherapeutics and Nano-Imaging Agents," Northeastern University, Boston, MA.

October, 2011, "Nudging Cells Using Molecular Interactions: Direct Separation of Cells in a Flow," Massachusetts Institute of Technology, Cambridge, MA.

May 2012, "Ionic and Molecular Transport through Graphene Membranes," NATO Advanced Research Workshop, Alternative Water Resources in Arid Areas by Retrieving Water from Secondary Sources, Daniel Dead Sea Hotel, Israel.

June 2012, "Measuring Ionic and Molecular Transport through Graphene Membranes," Boston Area Carbon Nanoscience (BACON) Meeting, Boston University, Boston, MA.

August 2012, "Nudging Cells Using Molecular Interactions: Direct Separation and Analysis of Cells in a Continuous Flow," Department of Mechanical Engineering, Iowa State University, Ames, IA.

October 2012, "Nudging Cells Using Molecular Interactions: Direct Separation and Analysis of Cells in a Continuous Flow," Department of Mechanical Engineering, Texas Tech University, Lubbock, TX.

February 2013, "Microfluidics for Synthesis and Development of Nanotherapeutics and Nano-Imaging Agents," 2013 ASME Global Congress on Nano Engineering for Medicine and Biology (NEMB 2013), Boston, MA.

February 2013, "Nudging Cells Using Molecular Interactions: Direct Separation and Analysis of Cells in Continuous Flow," Department of Mechanical Engineering, Ohio State University, Columbus, OH.

March 2013, "Nudging Cells Using Molecular Interactions: Direct Separation and Analysis of Cells in Continuous Flow," University of Waterloo Biomedical Seminar Series, Waterloo, Canada.

March 2013, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions," US-Japan Young Researcher Exchange, Massachusetts Institute of Technology, Cambridge, MA.

April 2013, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions," Department of Mechanical Engineering, Stanford University, Palo Alto, CA.

April 2013, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions," Berkeley Sensor and Actuator Center, University of California, Berkeley, CA.

April 2013, "Nanostructured Membranes for Water Purification and Gas Separations," Department of Mechanical Science and Engineering, University of Illinois Urbana-Champaign, Urbana, IL.

August 2013, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," Department of Chemical and Biomolecular Engineering, Sogang University, Korea.

August 2013, "Microfluidics for Synthesis and Development of Nanomedicines," Keynote lecture, 3rd Asia-Pacific Chemical and Biological Microfluidics Conferences, Seoul, Korea.

August 2013, "Microfluidics for Synthesis and Development of Nanotherapeutics and Nano-imaging Agents," Theranostic Macromolecules Research Center, Sungkyunkwan University, Korea.

October 2013, "Development of Nanostructured Membranes for Water Purification and Gas Separations," Division of Materials Science and Engineering, Boston University, Boston, MA.

January 2014, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," International Workshop on Advances in Healthcare Engineering, College of Engineering and Management, Kolaghat, India.

March 2014, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," Microfluidics Workshop, Microfluidics in Biomedical Sciences Training Program, University of Michigan, Ann Arbor, MI.

May 2014, "Nanostructured Membranes for Water Filtration and Desalination," 1st International Conference on Micro and Nanofluidics, Twente, Netherlands.

June 2014, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," 88th ACS 2014 Colloids and Surface Science Symposium, Philadelphia, PA.

July 2014, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," Micro- and Nanotechnologies for Medicine: Emerging Frontiers and Applications Workshop, Cambridge, MA.

September 2014, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," Lab-on-a-Chip & Microarray World Congress, San Diego, CA.

October 2014, "Experimental Investigation of Mass Transport and Filtration across Nanoporous Monolayer Graphene Membranes," CECAM Workshop- Nanofluidics in Physics and Biology, EPFL, Lausanne, Switzerland.

February 2015, "Label-Free Cell Sorting and Analysis Using Weak Molecular Interactions," Novartis Institutes for Biomedical Research, Cambridge, MA.

March 2015, "Engineering Flows in Nanostructured Materials: From Graphene Membranes to Xylem Filters," Department of Mechanical Engineering, University of Massachusetts Amherst, Amherst, MA.

March 2015, "Label-Free Cell Sorting and Analysis Using Weak Molecular Interactions," Squishy Physics Seminar Series, Harvard University, Cambridge, MA.

April 2015, "Engineering Flows in Nanostructured Materials: From Graphene Membranes to Xylem Filters," Department of Physics, Northeastern University, Boston, MA.

June 2015, "Nanofluidic Transport in Single-Layer Graphene Membranes," Gordon Research Conference on the Physics and Chemistry of Microfluidics, West Dover, VT.

June 2015, "Engineering Mass Transport and Filtration across Nanoporous Single-layer Graphene Membranes," Environment and Water Industry Technology Workshop 2015: Graphene for Desalination: The Path Forward, PUB, Singapore.

August 2015, "Nanofluidic Transport across Nanoporous Monolayer Graphene Membranes," 250th ACS National Meeting and Exposition, Boston, MA.

December 2015, "Direct Separation and Analysis of Cells Mediated by Transient Molecular Interactions in Microfluidic Devices," 2015 International Chemical Congress of the Pacific Basin Societies, Honolulu, HI.

February 2016, "Engineering Flows in Nanostructured Materials," Mechanical and Industrial Engineering seminar, University of Toronto, Toronto, Canada.

June 2016, "Graphene Membranes for Water Purification," Workshop on: Two-Dimensional Materials: Probing the Limits of Physics and Engineering, Fundacion Ramon Areces & MIT, Madrid, Spain.

August 2016, "Nanostructured Membranes for Water Purification and Separations," Tata Steel Inc., Jamshedpur, India.

November 2016, "Engineering Flows in Nanostructured Membranes for Water Purification and Separations," National Academies 4th Arab-American Frontiers of Science, Engineering and Medicine Symposium, Masdar Institute, Abu Dhabi, U.A.E.

Professional Service

Departmental and Institute Service

M.E. Graduate Admissions Committee (Dept.)	Jan. 2008 – March 2008
Undergraduate Programs Committee (Dept.)	Sept. 2008 – Jan. 2016
M.E. Graduate Admissions Committee (Dept.)	Jan. 2009 – March 2009
M.E. Graduate Admissions Committee (Dept.)	Jan. 2010 – March 2010
Bioengineering Faculty Search Committee (Dept.)	Oct. 2010 – July 2011
M.E. Graduate Admissions Committee (Dept.)	Jan. 2011 – March 2011
Micro/Nano Engineering Laboratory Instructor Search Committee	May 2011 – Aug. 2011

(Dept.)	
Organizer, MechE Research Speed Dating Event	Feb. 2012
Chair, Mechanical Engineering Colloquia	Jan. 2012 – Dec. 2015
M.E. Graduate Admissions Committee (Dept.)	Jan. 2012 – March 2012
M.E. Graduate Admissions Committee (Dept.)	Jan. 2013 – March 2013
M.E. Graduate Admissions Committee (Dept.)	Dec. 2013 – March 2014
Undergraduate Programs Committee International Affairs (Dept.)	Sept. 2012 – Oct. 2016
Organizer, Joint Workshop with Tokyo Institute of Technology (Dept.)	July 2014 – September 2014
Ad hoc committee on the M. E. Qualifying Exam (Dept.)	Sept. 2014 – May 2015
M. E. Faculty Search Committee (Dept.)	Dec. 2014 – April 2015
M. E. Graduate Admissions Committee (Dept.)	Dec. 2014 – March 2015
MIT M.E. – Tokyo Tech Collaboration (Dept.)	Dec. 2014 – present
M. E. Strategic Planning Committee (Dept.)	Sept. 2015 – Oct. 2016
M. E. Undergraduate Officer	July 2016 – present
Chair, Undergraduate Programs Committee (Dept.)	Sept. 2016 – present
M. E. Faculty Search Committee (Dept.)	Nov. 2016 – present
M. E. Graduate Admissions Committee (Dept.)	Dec. 2016 – March 2017

Other Service

NSF Review Panel (Thermal Transport Processes)	April 2007
Journal paper reviews, 2007-present	-
ACS Applied Materials and Interfaces, ACS Nano, Analytical Chemistry, Analytical and Bioanalytical Chemistry, Applied Physics Letters, Biomedical Microdevices, Biomicrofluidics, Biotechnology and Bioengineering, Chemical Physics Letters, Desalination, Desalination and Water Treatment, Electrophoresis, IEEE Sensors, Integrative Biology, Journal of Applied Physics, Journal of Heat Transfer, Journal of Materials Chemistry A, Journal of Membrane Science, Journal of Microelectromechanical Systems, Journal of Physical Chemistry, Journal of Membrane Science, Journal of the American Chemical Society, Lab on a Chip, Microfluidics and Nanofluidics, Nanoscale, Nano Letters, Nature, Nature Communications, Nature Materials, Nature Nanotechnology, Physical Chemistry and Chemical Physics, Physical Review X, Physics of Fluids, PNAS, Science, Science Advances, Scientific Reports, Sensors and Actuators, Small, Soft Matter.	
Judging panel for Senturia prize (MIT)	April 2008
Session Chair, MEMS Materials and MEMS for Materials, MEMS@MIT	Nov. 2008
Bioinstrumentation Session Chair, Northeast Bioengineering Conference (NEBEC 2009), Boston, MA	April 2009
Proposal Reviewer, Biotechnology and Biological Sciences Research Council (BBSRC), UK	April 2009
Proposal reviewer for Deshpande Center for Technological Innovation	June 2009
Poster Session Judge, 13 th International Conference on Miniaturized Systems for Chemistry and Life Sciences (microTAS)	Nov. 2009
NSF Review Panel (Biological Separations)	April 2010
Host for the visit of the Bios Lab-on-a-Chip group from University of Twente	June 2010
Hosted Dr. Yang from Singapore University of Technology and Design in the laboratory as part of “Teach the teachers” program	Jan. 2011 – Dec. 2011
Coordinated Micro/Nano area effort to create display for the Hart Museum in Bldg. 5	March 2011 – April 2011

Proposal reviewer for Carver Trust	July 2011
Proposal reviewer for Deshpande Center for Technological Innovation	July 2011
Reviewer for Singapore University of Technology and Design faculty search applications	July 2011
Proposal reviewer for DOE	April 2012
Proposal Reviewer for Swiss National Science Foundation	July 2012
NSF Review Panel (Chemical and Biological Separations)	Sept. 2012
Proposal reviewer for MIT International Science and Technology Initiatives (MISTI)	Oct. 2012
Article editor, PNAS	Oct. 2012
Session chair, 3 rd Asia-Pacific Chemical and Biological Microfluidics Conferences, Seoul, Korea, August 2013	Aug. 2013
Session chair, 2013 ASME Congress	Nov. 2013
Exhibit and Sponsorship Committee, 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences, San Antonio, TX, October 2014	Dec. 2013 – Oct. 2014
Advisory Board, Lab-on-a-Chip & Microarray World Congress, San Diego, CA, September 2014	Dec. 2013 – Sept. 2014
Session co-chair, Northeast Bioengineering Conference (NEBEC), Boston, April 2014	Dec. 2013 – April 2014
Proposal reviewer, Netherlands Organization for Scientific Research (NWO)	Dec. 2013
Editorial Board, Scientific Reports (Nature)	May 2014 – present
Poster judge, 1st International Conference on Micro and Nanofluidics, Twente, Netherlands	May 2014
Proposal reviewer, DOE Early Career program	Jan. 2015
'Carbon Nanofluidics' symposium organizer, 2016 MRS Spring Meeting	April 2015 – April 2016
Faculty candidate reviewer, Institute of Science and Technology, Austria	June 2015
Proposal reviewer, Kuwait Foundation for the Advancement of Science	July 2015
Proposal reviewer, Samsung Research Funding Center for Future Technology, Samsung Electronics	Sept. 2015
Session Chair, APS DFD meeting, Boston	Nov. 2015
Proposal reviewer, Netherlands Organization for Scientific Research	Feb. 2016
Proposal reviewer, Pierre Gilles De Gennes Institute	April 2016
Proposal reviewer, United Arab Emirates University	July 2016
Proposal reviewer, National Science Foundation SBIR/STTR Program	Oct. 2016
Reviewer, Canada Research Chair	Jan. 2017

Educational Contributions

Courses Taught

2007 Fall	2.671 Measurement and Instrumentation	Laboratory Instructor
2008 Spring	2.671 Measurement and Instrumentation	Laboratory Instructor
2008 Fall	2.006 Thermal and Fluids Engineering II	Recitation Instructor
2009 Spring	2.006 Thermal and Fluids Engineering II	Recitation Instructor
2009 Fall	2.005 Thermal and Fluids Engineering I	Recitation Instructor
2010 Spring	2.674/2.675 Micro/Nano Engineering Laboratory	Laboratory and Lecture Instructor
2010 Fall	2.006 Thermal and Fluids Engineering II	Lecture and Recitation Instructor

2011 Spring	2.674/2.675 Micro/Nano Engineering Laboratory	Laboratory and Lecture Instructor
2011 Fall	2.006 Thermal and Fluids Engineering II	Lecture Instructor
2012 Spring	2.674/2.675 Micro/Nano Engineering Laboratory	Laboratory and Lecture Instructor
2012 Fall	2.006 Thermal and Fluids Engineering II	Lecture Instructor
2013 Fall	2.006 Thermal and Fluids Engineering II	Lecture Instructor
2014 Spring	2.006 Thermal and Fluids Engineering II	Lecture Instructor
2014 Fall	2.674/2.675 Micro/Nano Engineering Laboratory	Laboratory and Lecture Instructor
2015 Spring	2.55 Advanced Heat & Mass Transfer	Lecture Instructor
2015 Fall	2.674/2.675 Micro/Nano Engineering Laboratory	Laboratory and Lecture Instructor
2016 Fall	2.006 Thermal and Fluids Engineering II	Lecture Instructor

Classroom Teaching Materials Developed

1. Provided inputs to improve laboratory handouts and modules in 2.671 (Measurement and Instrumentation) in Fall 2007.
2. Designed questionnaire for project proposal in 2.671 in Spring 2008 to help students plan their experiment and anticipate results and practical difficulties.
3. As guest lecturer, prepared and delivered a lecture on Scaling Issues in Nanofluidics in 2.76 (Multi-Scale System Design and Manufacturing) in Fall 2007.
4. Prepared and delivered a lecture on Biosensors in 2.671 in Spring 2008.
5. As guest lecturer, presented two lectures on Polymers in MEMS in 2.373 (Materials and Processes for Microelectromechanical Devices and Systems) in Spring 2008.
6. Developed lecture content on microfluidic mixing, two-phase flows, electrokinetics, nanoscale heat transfer, scanning tunneling microscopy, and surface modification and patterning for 2.674 (Micro/Nano Engineering Laboratory) in Spring 2010 and Spring 2011).

Educational Contributions Apart from Classroom Teaching

1. Prepared a new laboratory module on engineering of surfaces for 2.674 (Micro and Nano Engineering Laboratory) during Fall 2009, which was implemented in Spring 2010. The module includes microcontact printing, self-assembled monolayers, and patterning of biomolecules.
2. Prepared and introduced a new laboratory module on microscale heat transfer, where a thermochromic dye was used to visualize temperature, for 2.674 in Spring 2010.
3. Revised 2.674 modules on microfluidics incorporating feedback from previous year, adding experiment on electrokinetic separation of dyes and modifying experiments on mixing and two-phase microfluidics in Spring 2010.
4. Contributed to writing proposals for enhancing 2.674 to King Fahd University of Petroleum and Minerals and Lufkin foundation; the department was awarded the Lufkin foundation grant.
5. Worked closely with colleague (Prof. Sang-Gook Kim) to upgrade equipment for 2.674 including purchase of SEM, STM, and educational AFMs.
6. Developed an experimental module "Lego with Molecules" for high school women in the Women's Technology Program in summer 2010. It was implemented again in Summer 2011.
7. Developed a new laboratory module on scanning tunneling microscopy (STM) for 2.674 in Spring 2011.
8. Organized a tour of the Center for Materials Science and Engineering (CMSE) electron microscopy facility in Spring 2011 for 2.674 students, which included demonstrations of high-resolution TEM imaging and focused ion beam (FIB) milling.
9. Revised microfluidics laboratory modules for further streamlining for 2.674 in Spring 2012.
10. Set up student exchange program with the Department of Mechanical and Process Engineering at ETH Zurich as part of Undergraduate Programs Committee International Affairs in 2013.

11. Involved in transfer 2.674 (Micro/Nano Engineering Laboratory) course to King Fahd University of Petroleum and Minerals.
12. Helped to set up student exchange program with the University of Tokyo as part of Undergraduate Programs Committee International Affairs in 2015.

Bachelor's Theses

- Rondenay, Alix, "Introducing Three-Dimensional Flows in Planar Microfluidics for Mixing at Low Reynolds Numbers, ENSMP-MIT exchange student project, 2008.
- Sung, Minhee, "The Effect of P-selectin Pattern Band Width on the HL-60 Cell Rolling Behavior along an Edge," June 2010.
- Gilson, Laura, "Characterization of a Coaxial Turbulent Jet Mixer for Synthesis of Nanoparticles," June 2013.
- Potash, Benjamin, "Characterization and Preservation Techniques of Plant Xylem as Low Cost Membrane Filtration Devices," June 2014.

Master's Theses

- Sen, Yi-Heng, "Nanofluidic System for Single Molecule Manipulation and Analysis," September 2008.
- Bose, Suman, "A Microvillus Based Approach to Model Cell Rolling," September 2009.
- Raafat, Mohamed, "Self-Sorting of Deformable Particles in a Microfluidic Circuit," September 2010.
- Jain, Tarun, "Membrane Transfer Process for the Creation of Low-Noise Solid State Nanopore Devices," June 2011.
- O'Hern, Sean, "Development of Process to Transfer Large Areas of LPCVD Graphene from Copper Foil to a Porous Support Substrate," September 2011.
- Au, Harold, "Molecular Dynamics Simulations of Gas Transport through Pores in Graphene," September 2012. (Co-supervised with Prof. Nicolas Hadjiconstantinou)
- Jang, Doojoon, "Development of Experimental Methods to Measure Osmosis-Driven Water Flux and Molecular Transport across Nanoporous Graphene Membranes," June 2015.
- Ramchander, Krithika, "Development of Xylem-Based Water Filters," June 2016.
- Emily Hanhauser, "Dry Sample Preservation for Water Quality Analysis," expected June 2017. (Co-supervised with Prof. John Hart)

Doctoral Theses, Supervisor

- Sen, Yi-Heng, "DNA Ruler: Enhancing Nanopore Sizing Resolution by Multiple Measurements on the Same DNA Molecule," September 2012.
- Valencia, Pedro M., "Microfluidic System for High-Throughput Synthesis and Screening of Polymeric Nanoparticles for Targeted Drug Delivery," November 2012. (Co-supervised with Prof. Robert Langer and Dr. Omid Farokhzad)
- Cartas, Marco Ayala, "Hydrodynamic Resistance and Sorting of Deformable Particles in Microfluidic Circuits," January 2013.
- Bose, Suman, "Affinity Flow Fractionation for Label-Free Cell Sorting," September 2013.
- Lee, Chia-Hua, "Engineered Substrates to Control Cell Adhesion," January 2014.
- Lee, Jongho, "Desalination of Water by Vapor Transport through Hydrophobic Nanopores," July 2014.
- O'Hern, Sean, "Nanoporous Monolayer Graphene Membranes for Water Purification: From Concept to Realization," October 2014.
- Jain, Tarun, "Ion Transport across Individual Sub-Continuum Graphene Nanopores: Phenomenology, Theory, and Implications for Industrial Separations," January 2015.
- Boutilier, Michael, "Development of Macroscopic Nanoporous Graphene Membranes for Gas Separation," November 2016. (Co-supervised with Prof. Nicolas Hadjiconstantinou)

Chopra, Sunandini, "Development of Nanoparticles for Oral Delivery of Insulin," expected February 2017.

Jang, Doojoon, "Enhancing Selectivity and Flux in Nanoporous Graphene Membranes," expected December 2017.

Ramchander, Krithika, "Filtration and Isolation of Bacteria for Water Purification and Biomedical Diagnostics," expected June 2019.

Tellers, Mary, "Detection of Bacteria in Human Blood," expected June 2019.

Doctoral Theses, Reader

Urbanski, John Paul, "Microfluidics for Cellular Analysis," September 2008.

Choi, Wonjoon, "New Concepts in Energy and Mass Transport within Carbon Nanotubes," January 2012.

Kwak, Rhokyun, "Nonlinear Ion Concentration Polarization: Fundamentals and Applications," September 2013.

Chang, Jean, "Needle-free Interstitial Fluid Acquisition Using a Lorentz-Force Actuated Jet Injector," December 2013.

Jeon, Jessie, "In Vitro Study of Tumor Extravasation Using Microfluidics," December 2013.

Blasei, Aron, "The Design and Manufacture of Non-Porous, Immediate Release Dosage Forms," May 2014.

Humplik, Thomas, "Water and Ion Transport through Zeolites for Applications in Water Desalination," May 2014.

Goel Bajpayee, Ambika, "Development of Nanoparticle Based Drug Delivery System for Treating Post-Traumatic Osteoarthritis," January 2015.

Dighe, Aalap, "Design of a Neural Probe with Deployable Probes," June 2015.

Cui, Yuqing, "Study of Nucleation Mechanisms and Rational Design of Small-Scale Continuous Crystallizers," May 2016.

Hanks, Daniel, "Evaporation from Nanoporous Membranes for High Heat Flux Thermal Management," May 2016.

Hizir, Fahri Erinc, "Phase - Field Modeling of Liquids Splitting between Separating Surfaces and its Application to High - Resolution Roll - Based Printing Technologies," May 2016.

Schor, Alisha, "A Dielectrophoretic, Microfluidic Device for Sorting Lipid-Producing Organisms for Biodiesel Applications," May 2016.

Warsinger, David, "Fouling and Thermodynamic Design of Membrane Distillation Systems," June 2016.

Adera, Solomon, "Thin-Film Evaporation from Well-Defined Silicon Micropillar Wicks for High-Heat-Flux Thermal Management," September 2016.

Chehayeb, Karim, "Multi-Stage Electrodialysis for High Salinity Brine Concentration," expected June 2017.

Chou, Nigel, "High Throughput Growth Measurements of Glioblastoma Multiforme," expected June 2017.

De Puig Guixé, Helena, "Increasing sensitivity of lateral flow devices for rapid multiplexed disease diagnosis," expected December 2017.

Kim, Hyunho, "Development of Adsorption-based Advanced Thermal Battery and Water Harvesting Devices," expected June 2017.

Lu, Zhengmao, "Evaporation into Vacuum: Probing the Kinetic Limit," expected June 2017.

Mutha, Heena, "Hierarchical Carbon Nanotube Structures for Capacitive Deionization," expected June 2017.

Nayar, Kishor, "Improving Seawater Desalination and Seawater Desalination Brine Management," expected June 2017.

Shivanthu, Vivek, "A Study of Myofibrillogenesis in a Complex 3d Model of Skeletal Muscle," expected June 2017.

Swaminathan, Jai, "Membrane Distillation Configurations for High Salinity Concentration," expected June 2017.

Tow, Emily, "Organic Fouling in Osmotic Membrane Separation Processes," expected June 2017.

Lee, Hyundo, "Development of Microfluidic Testbeds for Oil-Reservoir Research," expected December 2017.

Wang, Gerald, "Cooking the Nano-Onion: Atomistic Engineering of Fluid Structure at the Fluid-Solid Interface," expected June 2018.

Postdoctoral Associates

<i>Name</i>	<i>Dates of Appointment</i>	<i>PhD Granting Institution</i>
Rhee, Minsoung	Jan. 2009 – Aug. 2011	University of Michigan, Ann Arbor
Lim, Jong-Min	June 2010 – Sept. 2014	Korea Advanced Institute of Science and Technology (KAIST)
Choi, Sungyoung	Sept. 2010 – March 2013	Korea Advanced Institute of Science and Technology (KAIST)
Yang, Hui Ying (Visiting scholar)	Jan. 2011– Dec. 2011	Nanyang Technological University, Singapore
Qasaimeh, Mohammad	Sept. 2013 – June 2014	McGill University
Kidambi, Piran	Sept. 2014 – present	University of Cambridge
Wang, Luda	Sept. 2014 – present	University of Colorado at Boulder
Bono, Michael	Sept. 2014 – present	Cornell University
Zhang, Sui	Oct. 2015 – present	National University of Singapore
Patel, Dineshkumar	Nov. 2016 – present	Ryerson University

Consulting

03/2008 – 11/2008
09/2014 – present
11/2014 – 11/2014
12/2014 – present

T2 Biosystems, Cambridge, MA.
A medical device startup company.
Daktari Diagnostics, Cambridge, MA.
A membrane startup company