CODY RITT

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EDUCATION

Yale University | New Haven, CT
- Ph.D. in Chemical and Environmental Engineering 06/2022
- M.Phil. in Chemical and Environmental Engineering 06/2019
- M.S. in Chemical and Environmental Engineering 05/2019

North Dakota State University (NDSU) | Fargo, ND
- M.S. in Civil Engineering 08/2017
- B.S. in Civil Engineering, (GPA 3.97/4.00), *summa cum laude* 05/2016

Normandale Community College | Bloomington, MN 08/2012 – 06/2013

RESEARCH EXPERIENCE

Postdoctoral Research Associate | MIT (PI: Michael Strano) 09/2022 – Present
- Developing two-dimensional (2D) polymers as impermeable barrier materials.
- Establishing theoretical framework for achieving nano-enhanced phytoremediators.
- Designing nanosensors for detecting emerging contaminants down to ~1 ppt.
- Studying fluid phase transition of water confined to single-digit carbon nanotubes.

NSF Graduate Research Fellow | Yale (PI: Menachem Elimelech) 08/2017 – 08/2022
- Established a database for advancing the study of reverse osmosis membranes.
- Elucidated fundamental structure–property–performance relationships in polymer membranes.
- Developed approach for measuring surface reactions under nanoconfinement.
- Identified defects as a limiting factor for novel material-based membranes via *in silico* techniques.
- Developed optical technique for characterizing permeable materials with ultralow flow rates.
- Created nanofluidic platforms to study slip flow in Å-scale channels.

NDWRRI Graduate Research Fellow | NDSU (PI: Achintya Bezbaruah) 05/2016 – 08/2017
- Designed and characterized molecularly imprinted polymers (MIPs) for phosphate remediation.
- Modified MIPs to optimize in-field applicability with maximum sorption capacity.

NSF Research Experience for Undergraduates | NDSU (PI: Achintya Bezbaruah) 08/2013 – 05/2016
- Studied kinetics of biopolymer phosphate sorption to elucidate removal mechanisms.
- Analyzed the impacts of nanoparticle introduction on soil physico-chemical properties.

AWARDS AND HONORS

- AEESP Outstanding Doctoral Dissertation Award 2023
- Schmidt Science Fellowship Finalist 2022
- ACS C. Ellen Gonter Environmental Chemistry Award 2021
- National Science Foundation Graduate Research Fellowship 2016
- North Dakota Water Resources Research Institute Fellowship 2016
- Barry M. Goldwater Scholarship 2015
- Astronaut Scholarship Foundation nomination from NDSU 2015
- North Dakota Water Education Foundation Scholarship 2015

- NDSU Class of 1939 Memorial Scholarship 2015
- Minnesota Society of Professional Engineers – Traverse Des Sioux Chapter Scholarship 2015
- North Dakota Society of Professional Engineers – Chapter 4 Scholarship 2015
- Charlie Parnell Memorial Scholarship 2015
- Minnesota Surveyors and Engineers Society Scholarship 2014, 2015
- Minnesota Society of Professional Engineers – Southwest Chapter Scholarship 2014
- Frank Murphy Scholarship 2014
- Verne E. Plath Scholarship 2014
- American Public Works Association – Minnesota Chapter Scholarship 2014
- Presidential Honor Scholarship 2013 – 2016
- North Dakota State University Dean's List 2013 – 2016
- Hamel Lions Memorial Scholarship 2013

JOURNAL PUBLICATIONS

9 first-author ([‡]equal contribution) and 1 corresponding-author (*) papers, 22 total, *h*-index = 14, # citations = 1347
— as of 07/07/2023 —

(1) L.F. Villalobos, K.E. Pataroque, W. Pan, T. Cao, M. Kaneda, C. Violet, **C.L. Ritt**, M. Elimelech, "Orientation Matters: Measuring the Correct Surface of Polyamide Membranes with Quartz Crystal Microbalance," *J. Membr. Sci. Lett.* 100048 (2023).

(2) M.G. Barsukov[‡], **C.L. Ritt[‡*]**, I.V. Barsukov, E.M. Syth, M. Elimelech, "Influence of graphite geography on the yield of mechanically exfoliated few-layer graphene," *Carbon* 208, 355-364 (2023).

(3) Aluru, N.R., Aydin, F., Bazant, M.Z., Blankschtein, D., Brozena, A.H., de Souza, J.P., et al., "Fluids and electrolytes under confinement in single-digit nanopores," *Chem. Rev.* 123, 2737-2831 (2023).

(4) **C.L. Ritt**, J.P. de Souz, M.G. Barsukov, S. Yosinski, M.Z. Bazant, M.A. Reed, M. Elimelech, "Thermodynamics of charge regulation during ion transport through silica nanochannels," *ACS Nano* 16, 15249-15260 (2022).

(5) M. Heiranian, R.M. DuChanois, **C.L. Ritt**, C.A. Violet, M. Elimelech, "Molecular simulations of transport phenomena in polymeric membranes: Implications for membrane design," *Environ. Sci. Technol.* 56, 3313-3323 (2022).

(6) **C.L. Ritt[‡]**, M. Nami[‡], M. Elimelech, "Laser interferometry for precise measurement of ultralow flow rates from permeable materials," *Environ. Sci. Technol. Lett.* 9, 233-238 (2022).

(7) **C.L. Ritt**, M. Liu, T.A. Pham, R. Epsztein, H.J. Kulik, M. Elimelech, "Machine learning reveals key ion selectivity mechanisms in polymeric membranes with subnanometer pores," *Sci. Adv.* 8, 2, eabl5771 (2022).

(8) **C.L. Ritt[‡]**, T. Stassin[‡], D.M. Davenport, R.M. DuChanois, I. Nulens, Z. Yang, N. Segev-Mark, A. Ben-Zvi, M. Elimelech, C.Y. Tang, G.Z. Ramon, I.F.J. Vankelecom, R. Verbeke, "The Open Membrane Database: Synthesis–structure–performance relationships of reverse osmosis membranes," *J. Membr. Sci.* 641, 119927 (2022).

(9) C. Lu, C. Hu, **C.L. Ritt**, X. Hua, J. Sun, H. Xia, Y. Liu, D. Li, B. Ma, M. Elimelech, J. Qu, "In situ characterization of dehydration during ion transport in polymeric nanochannels," *J. Am. Chem. Soc.* 143, 14242-14252 (2021).

(10) R. Verbeke, D.M. Davenport, T. Stassin, S. Eyley, M. Dickmann, J. Alexander, P. Dara, **C.L. Ritt**, C. Bogaerts, W. Egger, R. Ameloot, J. Meersschaut, W. Thielemans, G. Koeckelberghs, M. Elimelech, I.F.J. Vankelecom, "Chlorine-resistant epoxide-based membranes for sustainable water desalination," *Environ. Sci. Technol. Lett.* 8, 818-824 (2021).

(11) W.-H. Zhang, M.-J. Yin, Q. Zhao, C.-G. Jin, N. Wang, S. Ji, **C.L. Ritt**, M. Elimelech, Q.-F. An, "Graphene oxide membranes with stable porous structure for ultrafast water transport," *Nat. Nanotechnol.* 16, 337-343 (2021).

(12) **C.L. Ritt**, J.R. Werber, M. Wang, Z. Yang, Y. Zhao, H.J. Kulik, M. Elimelech, "Ionization behavior of nanoporous polyamide membranes," *Proc. Natl. Acad. Sci. U.S.A.* 117, 30191-30200 (2020).

(13) D.M. Davenport, **C.L. Ritt**, R. Verbeke, I.F.J. Vankelecom, M. Elimelech, "Thin film composite membrane compaction in high-pressure reverse osmosis," *J. Membr. Sci.* 610, 118268 (2020).

(14) X. Lu, U.R. Gabinet, **C.L. Ritt**, X. Feng, A. Deshmukh, K. Kawabata, M. Kaneda, S.M. Hashmi, C.O. Osuji, M. Elimelech, "Relating selectivity and separation performance of lamellar two-dimensional molybdenum disulfide (MoS_2) membranes to nanosheet stacking behavior," *Environ. Sci. Technol.* 54, 9640-9651 (2020).

(15) R. Epsztein, R.M. DuChanois, **C.L. Ritt**, A. Noy, M. Elimelech, "Towards single-species selectivity of membranes with subnanometre pores," *Nat. Nanotechnol.* 15, 426-436 (2020).

(16) C.J. Porter, J.R. Werber, **C.L. Ritt**, Y.F. Guan, M. Zhong, M. Elimelech, "Controlled grafting of polymer brush layers from porous cellulosic membranes," *J. Membr. Sci.* 596, 117719 (2020).

(17) S.K. Patel‡, **C.L. Ritt‡**, A. Deshmukh, Z. Wang, M. Qin, R. Epsztein, M. Elimelech, "The relative insignificance of advanced materials in enhancing the energy efficiency of desalination technologies," *Energy Environ. Sci.* 13, 1694-1710 (2020).

(18) F. Aydin, C. Zhan, **C.L. Ritt**, R. Epsztein, M. Elimelech, E. Schwegler, T.A. Pham, "Similarities and differences between potassium and ammonium ions in liquid water: A first-principles study," *Phys. Chem. Chem. Phys.* 22, 240-2548 (2020).

(19) **C.L. Ritt‡**, J.R. Werber‡, A. Deshmukh, M. Elimelech, "Monte Carlo simulations of framework defects in layered two-dimensional desalination membranes: Implications for permeability and selectivity," *Environ. Sci. Technol.* 53, 6214-6224 (2019).

(20) J. Luo, M. Sun, **C.L. Ritt**, X. Liu, Y. Pei, J. Crittenden, M. Elimelech, "Tuning Pb(II) adsorption from aqueous solutions on ultrathin iron oxychloride (FeOCl) nanosheets," *Environ. Sci. Technol.* 53, 2075-2085 (2019).

(21) **C.L. Ritt**, B.J. Chisholm, A.N. Bezbaruah, "Assessment of molecularly imprinted polymers as sustainable phosphate sorbents" *Chemosphere*, 226, 395-404 (2019).

(22) M.E. Hossain, **C.L. Ritt**, T. Almeelbi, A.N. Bezbaruah, "Biopolymer beads for aqueous phosphate removal: Possible Application in eutrophic lakes," *J. Environ. Eng.* 144, 04018030 (2018).

Submitted or In Preparation

(1) **C.L. Ritt** and M.S. Strano, "Leveraging plant nanobionics to engineer next-generation phytoremediation technologies," (*in preparation*).

(2) **C.L. Ritt**, M. Quien, Z. Yuan, Y.-M. Tu, J.S. Bunch, M.S. Strano, "Ultra-low gas permeability of irreversibly bonded two-dimensional polyaramid (2DPA-1) films," (*in preparation*).

(3) M. Kuehne, Y.-M. Tu, **C.L. Ritt**, *et al.* "Anomalous environmental damping in vibrationally coupled carbon nanotubes," (*submitted to Nat. Nanotechnol.*)

CONFERENCE PROCEEDINGS

(1) M. Nami, **C.L. Ritt**, Y. Li, J. Wang, M.A. Reed, "Investigating the Ionic Transport and Charge Inversion in Monovalent Nanofluidic Structures," *15th IEEE-NEMS* (2020).

(2) M.E. Hossain, T. Almeelbi, **C.L. Ritt**, A.N. Bezbaruah, "Biopolymer beads for aqueous phosphate removal: Possible application in eutrophic lakes," *Proc. World Environment and Water Resources Congress* (2014).

INVITED TALKS

- **C.L. Ritt**, *et al.*, "Plant nanobionics: The key to next-generation phytoremediators?," *AEESP Research and Education Conference*, Boston, MA (2023).
- **C.L. Ritt**, *et al.*, "Hard polymers: Irreversible synthetic routes to ultra-strong 2D polymers in bulk," *243rd ECS Meeting*, Boston, MA (2023).
- **C.L. Ritt**, *et al.*, "Thermodynamics of charge regulation during ion transport through silica nanochannels," *MRS Fall Meeting*, Boston, MA (2022).
- **C.L. Ritt**, *et al.*, "Laser interferometry as a versatile platform for characterizing nanoscale flow rates in permeable materials," *TAHOE Nanofluidics 2022*, Tahoe City, CA (2022) and *North American Membrane Society Meeting,* Tempe, AZ (2022).
- **C.L. Ritt**, *et al.*, "Heterogeneous ionization of polyamide membranes: Implications for reverse osmosis and nanofiltration," *Wetsus Symposium*, Leeuwarden, Netherlands (2022).
- **C.L. Ritt** and R.S. Kingsbury, "Practical Python for the Water Researcher," *National Alliance for Water Innovation (NAWI) UnConference Session*, virtual (2021).
- **C.L. Ritt**, *et al.*, "Molecular mechanisms of ion selectivity in nanoporous polymeric membranes," *North American Membrane Society Meeting*, Estes Park, CO (2021).
- **C.L. Ritt**, *et al.*, "Open-access database for desalination and water purification membranes," presented at *ACS Fall National Meeting & Exposition*, Atlanta, GA (2021) and *North American Membrane Society Meeting*, Estes Park, CO (2021).
- **C.L. Ritt**, *et al.*, "Monte Carlo simulations of layered 2-D nanomaterials: Understanding the influence of framework defects during membrane separation," *ACS Fall National Meeting & Exposition*, Boston, MA (2018).

TEACHING AND MENTORING

Teaching Fellow | Yale, Intro to Environmental Engineering (ENVE 120) 01/2019 – 05/2019

- Instructed undergraduates on the use of chemistry in environmental engineering applications.

Teaching Assistant | NDSU, Fluid Mechanics Laboratory (CE310) 01/2016 – 05/2017

- Taught principles and applications of fluid mechanics in civil engineering.

Teaching Assistant | NDSU, Introduction to Civil Engineering (CE111) 01/2015 – 05/2015

- Reviewed and assisted students with Microsoft Excel-intensive assignments.

Graduate Student Mentoring

- Michelle Quien | MIT, Chemical Engineering 09/2022 – Present
  - Project: *Ultralow Air Permeability of 2D Polymer Films*

- Camille Violet | Yale University, Environmental & Chemical Engineering 08/2019 – 08/2022
    - Project: *The Role of Specific Chemical Interactions in Selective Ion Transport*

Undergraduate Student Mentoring

- Dora Ogbonna | University of California – San Diego, Chemical Engineering 05/2021 – 08/2022
    - Goldwater Scholar Community Mentorship Program
- Michelle Barsukov | Yale University, Chemical Engineering 01/2020 – 08/2022
    - Project: *Influence of Graphite Geography on the Yield of Exfoliated Few-Layer Graphene*
- Christian Martinez | Yale University, Economics 02/2021 – 05/2021
    - Project: *The Open Membrane Database*

INDUSTRY EXPERIENCE

Consultant | Plazmod, New Haven, CT 03/2022 – 07/2022

- Characterized plasma-based nanometric film depositions on copper substrates.

Founding Member | The Open Membrane Database, New Haven, CT 08/2021 – Present

- Led an international collaboration to develop an open-access membrane database.
- Produced performance and characterization calculators for database.

Engineering Intern | Hakanson Anderson Associates Inc., Anoka, MN 05/2015 – 08/2015

- Designed wastewater treatment facility expansion for the City of Bethel, MN.
- Constructed AutoCAD watershed map to model flow habits/water quality and develop BMPs.
- Created ArcMap exhibits to track municipal utilities, inspections, and ponds.

TECHNICAL SKILLS

Experimental/Analytical

- Transmission Electron Microscopy
- Microtome
- Atomic Force Microscopy
- Electron Beam Lithography
- Scanning Electron Microscopy
- Raman Spectroscopy
- FTIR Spectroscopy

Computational

- Python
- Adobe Illustrator
- Origin
- AUTOCAD
- COMSOL
- ArcGIS
- MATLAB

CONTRIBUTIONS TO GRANTS

Awarded

(1) M.S. Strano, "Development of Novel Two-Dimensional Polymer Membranes for Liquid Separations." MITEI Seed Fund (2023). Awarded $150,000. Contributions: co-written all technical sections and management planning; designed 4 (of 6) figures.

(2) M.S. Strano, *et al.*, "The Center for Enhanced Nanofluidic Transport ($CENT^2$) Renewal." DOE EFRC (2022). # *DE-SC0019112*. Awarded $10.8 million. Contributions: co-written 4 (of 12) technical sections.

LEADERSHIP AND SERVICE

Peer Reviewer 2017 – Present

- *Sci. Adv.* (2 manuscripts)

- *ACS ES&T Eng.* (1 manuscript)
- *Environ. Sci. Technol.* (3 manuscripts)
- *Environ. Sci. Technol. Lett.* (3 manuscripts)
- *ACS Appl. Mater. Interfaces* (2 manuscripts)
- *Chemosphere* (1 manuscript)
- *Chem. Eng. Sci.* (1 manuscript)
- *Water. Environ. Res.* (1 manuscript)

Professional Affiliations

- Goldwater Scholar Community (GSC)
- North American Membrane Society (NAMS)
- American Chemical Society (ACS)
- American Society of Civil Engineers (ASCE)
- Materials Research Society (MRS)
- American Water Works Association (AWWA)
- Water Environment Federation (WEF)
- Tau Beta Pi Engineering Honor Society
- Phi Theta Kappa Honor Society
- National Society of Collegiate Scholars

University Service

- DOE Center for Enhanced Nanofluidic Transport (CENT) 2018 – Present
  - Senior Associate Executive Director 2023 – Present
- NSF Research Center for Nano-Enabled Water Treatment (NEWT) 2018 – 2022
  - Social Chair 2018
- NDSU Dept. Civil & Environ. Eng. Faculty Search Committee 2016
- NDSU ASCE | *Student Chapter Officer* 2013 – 2015
- NDSU AWWA/WEF | *Student Chapter President* 2014 – 2015

Conferences and Symposiums

- AEESP Research and Education Conference, Boston, MA | *Organizer* 06/2023
- 18th Annual Robert M. Langer Symposium, New Haven, CT | *Consultant* 12/2021
- 16th Annual Robert M. Langer Symposium, New Haven, CT | *Chair* 12/2018
- 1st Annual Equity in the Job Search Symposium, New Haven, CT | *Organizer* 05/2017
- International Prairie Student Conference, Fargo, ND | *Organizer* 06/2014

Outreach

- NSF-GRFP panelist for GSC 2021
- CT SEED (educating children in sciences) | *Volunteer* 2018 – 2022
- Girls Science Investigations | *Volunteer* 2018 – 2022
- NEWT Café (educating children in nanosciences) | *Volunteer* 2018
- K-12 STEM outreach for homeschooled students | *Volunteer* 2016
- The Big World of Nanotechnology Summer Program | *Developer and Director* 2016
  - Week-long science outreach program for middle school children
- North Dakota Water and Pollution Control Conference Service Project | *Volunteer* 2014
- Children International | *Child Sponsor* 2013 – Present