

Education

Stanford University

Stanford, CA

Ph.D. in Chemical Engineering, Advisors: Andrew Spakowitz, Sarah Heilshorn

2018–2023

Thesis: “Polymer physics driven design and understanding of biological materials”

Massachusetts Institute of Technology (MIT)

Cambridge, MA

B.S. in Chemical Engineering, GPA: 5.0/5.0, Phi Beta Kappa

2012–2016

Minor: Music Performance and Theory

Professional Appointments

University of Chicago

Chicago, IL

Arnold O. Beckman Postdoctoral Fellow

2024–

Postdoctoral Scholar

2023–2024

Publications

1. **PC Cai**, A Ghosh, and AJ Spakowitz. “Fluctuation-driven theory for polyelectrolyte rheology,” *In preparation*, 2024.
2. EB Burgener, LS Rojas-Hernandez, NS Joo, **PC Cai**, MJ Kratochvil, A Gupta, K Nakano, S Gibbs, M Bach, C Dunn, J Spano, P Secor, L Tian, SC Heilshorn, AJ Spakowitz, JJ Wine, PL Bollyky, and CE Milla. “Effects of the *Pseudomonas* phage Pf on mucociliary transport and lung function in cystic fibrosis,” *In preparation*, 2024.
3. M Ayushman, G Mikos, S Sinha, E Lopez-Fuentes, S Jones, **PC Cai**, X Tong, AJ Morrison, AJ Spakowitz, SC Heilshorn, A Sweet-Cordero, and F Yang. “Cell Dancing Enhances Stem Cell Differentiation in 3D Hydrogels via Nuclear Mechanotransduction,” *In revision*, 2024.
4. Q Chen*, **PC Cai***, THW Chang, EB Burgener, MJ Kratochvil, A Gupta, A Hargill, PR Secor, J Nielsen, AE Barron, CE Milla, SC Heilshorn, AJ Spakowitz, and PL Bollyky. “Pf bacteriophages hinder sputum antibiotic diffusion via electrostatic binding,” in *Science Advances (Accepted)*, 2024.
5. **PC Cai***, M Braunreuther*, A Shih, AJ Spakowitz, SC Heilshorn, and GG Fuller. “Air-liquid intestinal cell culture allows *in situ* rheological characterization of intestinal mucus,” in *APL Bioengineering (Accepted)*, 2024.
6. **PC Cai**, B Su, L Zou, MJ Webber, SC Heilshorn, and AJ Spakowitz. “Rheological Characterization and Theoretical Modeling Establish Molecular Design Rules for Tailored Dynamically Associating Polymers,” in *ACS Central Science*, 8(9), 1318-1327, 2022.
7. Q Chen, T Dharmaraj, **PC Cai**, EB Burgener, NL Haddock, AJ Spakowitz, and PL Bollyky. “Bacteriophage Impact on Bacterial Susceptibility, Resistance, and Tolerance to Antibiotics,” in *Pharmaceutics*, 17(7), 1425, 2022.
8. MJ Kratochvil*, G Kaber*, S Demirdjian*, **PC Cai**, EB Burgener, N Nagy, GL Barlow, MC Popescu, MR Nicolls, MG Ozawa, DP Regula, AE Pacheco-Navarro, S Yang, V de Jesus Perez, H Karmouty-Quintana, A Peters, B Zhao, LM Buja, PY Johnson, RB Vernon, TN Wight, Stanford COVID-19 Biobank Study Group, AJ Rogers, AJ Spakowitz, CE Milla, SC Heilshorn, and PL Bollyky. “Biochemical, biophysical, and immunological characterization of respiratory secretions in severe SARS-CoV-2 infections,” in *JCI Insight*, 7(12), 2022.
9. DR Hunt, KC Klett, S Mascharak, H Wang, D Gong, J Lou, X Li, **PC Cai**, RA Suhar, JY Co, BL LeSavage, AA Foster, Y Guan, MR Amieva, G Peltz, Y Xia, CJ Kuo, and SC Heilshorn. “Engineered Matrices Enable the Culture of Human Patient-Derived Intestinal Organoids,” in *Advanced Science*, 8: 2004705, 2021.

10. BA Krajina, BL LeSavage, JG Roth, AW Zhu, **PC Cai**, AJ Spakowitz, and SC Heilshorn. “Microrheology reveals simultaneous cell-mediated matrix stiffening and fluidization that underlie breast cancer invasion,” in *Science Advances*, 7: eabe1969, 2021.
11. **PC Cai**, BA Krajina, MJ Kratochvil, L Zou, A Zhu, EB Burgener, PL Bollyky, CE Milla, MJ Webber, AJ Spakowitz, and SC Heilshorn. “Dynamic light scattering microrheology for soft and living materials,” in *Soft Matter*, 17: 1929-1939, 2021.
12. **PC Cai**, BA Krajina, AJ Spakowitz. “Brachiation of a polymer chain in the presence of a dynamic network,” in *Physical Review E*, 102, 020501(R), 2020.

Honors & Awards

Arnold O. Beckman Postdoctoral Fellowship, Arnold & Mabel Beckman Foundation	2024–2026
PMSE Future Faculty, American Chemical Society (ACS)	2024
Global Outstanding Student Award in PMSE, ACS	2024
University of Chicago Pritzker School of Molecular Engineering Postdoc Travel Award	2024
Director’s Discretionary Allocation Grant, Argonne Leadership Computing Facility (ALCF)	2023–2024
Frank J. Padden, Jr. Award for Excellence in Polymer Physics Research, American Physical Society (APS)	2023
Stanford Bio-X Travel Award	2023
1st Place Speaker Award for Graduate Excellence in Polymer Research, AIChE	2022
MIT Rising Star in Chemical Engineering	2022
Justice Equity Diversity Inclusion (JEDI) Graduation Award, Stanford School of Engineering	2022
Stanford Chemical Engineering Department Service Award	2022
Braslau Family Travel Grant, APS	2022
Best Grad Student or Postdoc Talk Award, Biophysical Society (BPS)	2022
MIT Polymer Day 1st Place Poster	2021
Stanford Bio-X Honorary Fellow	2019–2022
National Science Foundation (NSF) Graduate Research Fellowship (GRFP)	2019–2022
Akiko Yamazaki and Jerry Yang Engineering Fellowship	2018
Phi Beta Kappa	2016
Robert T. Haslam Cup for showing most promise as a future chemical engineer, MIT	2016
Excellence in Leadership as AIChE President, MIT	2016
Lourdes C. and Wing S. Fong Memorial Prize, MIT	2016
Tau Beta Pi	2015
BP Prize for Excellence in Chemical Engineering, MIT	2015
MISTI-China Victor and William Fung Foundation Scholar, MIT	2013

Presentations

Invited

1. “Linking molecular structure to macroscopic rheology of dynamically associating polymer networks,” *APS March Meeting*. Las Vegas, NV. 2023. **Padden Award Winner**.
2. “A polymer physics approach to interrogating the mucus microenvironment,” *Princeton University Center for the Physics of Biological Function Symposium*. Princeton, NJ. 2022.
3. “Molecular-Level Theory for Rational Design of Dynamic Polymer Networks,” *AIChE Annual Meeting*. Phoenix, AZ. 2022. **1st Place Speaker Award Winner**.
4. “Molecular-Level Theory for Rational Design of Dynamic Polymer Networks,” *Polymer Physics Gordon Research Seminar*. South Hadley, MA. 2022.
5. “Leveraging Polymer Physics to Reduce Respiratory Secretions in Severe Cases of SARS-CoV-2 (COVID-19) Infection,” *Biophysical Society Annual Meeting*. San Francisco, CA. 2022. **Best Speaker Award Winner**.

6. “Biophysical Characterization of Respiratory Secretions in Severe SARS-CoV-2 (COVID-19) Infections,” *8th Annual Chemical Engineering Convocation and Research Symposium*. Stanford, CA. 2021.

Contributed

1. “Fully recyclable plastics from biopolymer-based polyelectrolyte complexes,” *ACS Spring Meeting*. New Orleans, LA. 2024.
2. “Molecular-Level Theory for Rational Design of Dynamic Polymer Networks,” *Polymer Physics Gordon Research Conference*. South Hadley, MA. 2022.
3. “Dynamic Light Scattering Microrheology for Soft and Living Materials,” *Society for Biomaterials Annual Meeting*. Baltimore, MD. 2022.
4. “A Molecular-Level Theory for Predicting Rheological Behavior of Dynamically Associating Polymer Networks,” *American Physical Society Annual Meeting*. Chicago, IL. 2022.
5. “Brachiation of a polymer chain in the presence of a dynamically associating network,” *2nd Annual Virtual Polymer Physics Symposium*. Virtual. 2021.
6. “Biophysical Characterization of Respiratory Secretions in Severe SARS-CoV-2 (COVID-19) Infections,” *10th Annual MIT Polymer Day*. Virtual. 2021. **1st Place Poster Award Winner**.

Mentoring

Jessica Ha (undergraduate, 2021)
 Baraah Abdo (undergraduate, 2021)
 Xin Ma (undergraduate, 2020)

Teaching

Guest Lecturer

UChicago MENG25120 Polymer Physics	Spring 2024
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Teaching Assistant

Stanford CHEMENG300 Applied Mathematics in the Chemical and Biological Sciences	Fall 2020
Stanford CHEMENG300 Applied Mathematics in the Chemical and Biological Sciences	Fall 2019

Outreach and Service

Journal Reviewing

Macromolecules, Soft Matter

Conference Chairing

Session Chair, ACS PMSE Centennial Session	2024
Discussion Leader, Polymer Physics Gordon Research Seminar (GRS)	2022

Department & University Service

Vice President, Stanford Polymer Collective (SPC), <i>Stanford, CA</i>	2022–2023
Chair, Stanford Chemical Engineering Convocation, <i>Stanford, CA</i>	2021
Vice President, Stanford Chemical Engineering Graduate Student Action Committee	2020–2021
Community Associate, Stanford Graduate Life Office (GLO)	2019–2023
President, MIT American Institute of Chemical Engineers (AIChE)	2015–2016
Educational Counselor, MIT	2016–

DEI & Outreach

Volunteer in Girls Advancing in STEM (GAINS), <i>Chicago, IL</i>	2023
Math Tutor at Wendell Phillips High School, <i>Chicago, IL</i>	2023–
Research Mentor for Stanford Undergraduate Research Fellows (SURF) Program, <i>Stanford, CA</i>	2021
Room Leader for Stanford Future Advancers of Science and Technology (FAST), <i>San Jose, CA</i>	2019–2023
Mentor in Minds Matter, <i>New York, NY</i>	2017–2018
Co-founder of MIT Code It!, <i>Cambridge, MA</i>	2015
Outreach Program Director of MIT Society of Women Engineers (SWE), <i>Cambridge, MA</i>	2014–2016