Pamela C. Cai

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Summary

- Materials scientist with 7+ years experience particularly in soft matter and polymers
- Expert in soft materials characterization, testing, and prototyping
- Interdisciplinary collaborator and strong technical communicator

Work Experience

University of Chicago — Chicago, IL
Arnold O. Beckman Postdoctoral Fellow, Advisor: Matthew Tirrell — 2023–

- Chemically modified biopolymers alginate and chitosan as a plastic alternative in single-use packaging materials that retains 98% of original mass across 6 recycles with comparable stiffness to LDPE and is biodegradable
- Developed melt press processing method for biopolymer-based materials to facilitate industrial adoption

Stanford University — Stanford, CA
National Science Foundation Graduate Research Fellow, Stanford Bio-X Fellow — 2018–2023

- Synthesized supramolecular hyaluronic acid-based host–guest polymer materials to exhibit soft material stiffness ranging from 1 to 1000 Pa
- Derived and experimentally validated new polymer physics theory for rationally designing dynamic polymers for applications such as re-processable plastics, drug delivery, tissue engineering, and 3D printing
- Refined noninvasive experimental technique (dynamic light scattering microrheology) and programmed an open-source data analysis package that characterizes physical behavior of soft materials over 6 decades in time
- Leveraged dynamic light scattering microrheology to show that enzymatic degradation of DNA and hyaluronic acid in COVID-19 mucus eases COVID-19 patient breathing difficulties
- Developed intestinal epithelium cell-culture model to probe mucus biophysical changes due to worm *N. brasiliensis* infection using magnetic microrheometer
- Proved using theoretical modeling that liquid crystal structures formed by filamentous bacteriophages in *P. aeruginosa* facilitate antibiotic tolerance by hindering antibiotic diffusion

Morgan Stanley — New York, NY
Exotic Derivatives Analyst — 2016–2018

- Developed and built 300+ pricing models of exotic derivative products using Monte Carlo simulations
- Facilitated collaboration with an interdisciplinary team of traders, quants, and sales professionals, driving a $1M+ revenue increase from a key client

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, Minor in Music Performance and Theory — 2012–2016

Skills

Programming: Python, MATLAB, JAX
Materials characterization: DSC, TGA, Rheometer, DMA, FTIR, NMR
Materials processing: 3D printing (DLP, SLA), melt press, spin-coating, organic synthesis, polymer purification

Selected Publications (6 of 12)

**co-first authors*

1. **PC Cai**, V Vaz, and MV Tirrell. "Enhancing polyelectrolyte strength of biopolymers for fully recyclable and biodegradable plastics," *In preparation*, 2024.
2. 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*, 10: eadl5576, 2024.
3. **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*, 8, 026112, 2024.
4. **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.
5. **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.
6. **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.

Selected Conference Presentations (6 of 25)

1. "Pf bacteriophages hinder sputum antibiotic diffusion via electrostatic binding," *APS Global Physics Summit*. Anaheim, CA. 2025. ***DBIO Early Career Award Session Selected Speaker***.
2. "Biopolymer solid polyelectrolyte complexes as biodegradable recyclable plastics," *Polymer Physics Gordon Research Conference*. South Hadley, MA. 2024. *Poster*.
3. "Linking molecular structure to macroscopic rheology of dynamically associating polymer networks," *APS March Meeting*. Las Vegas, NV. 2023. ***Padden Award Winner***.
4. "Molecular-Level Theory for Rational Design of Dynamic Polymer Networks," *AIChE Annual Meeting*. Phoenix, AZ. 2022. ***1st Place Speaker Award Winner***.
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," *10th Annual MIT Polymer Day*. Virtual. 2021. ***1st Place Poster Award Winner***.

Selected Honors & Awards

Arnold O. Beckman Postdoctoral Fellowship, Arnold & Mabel Beckman Foundation	2024–2026
Global Outstanding Student Award in Polymeric Materials Sci. & Eng., ACS	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
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
National Science Foundation (NSF) Graduate Research Fellowship (GRFP)	2019–2022
Robert T. Haslam Cup for showing most promise as a future chemical engineer, MIT	2016

Outreach

Math Tutor at Wendell Phillips High School, *Chicago, IL*	2023–
Vice President, Stanford Polymer Collective (SPC), *Stanford, CA*	2022–2023
Research Mentor for Stanford Undergraduate Research Fellows (SURF) Program, *Stanford, CA*	2021
Room Leader for Stanford Future Advancers of Science and Technology (FAST), *San Jose, CA*	2019–2023
Mentor in Minds Matter, *New York, NY*	2017–2018
Co-founder of MIT Code It!, *Cambridge, MA*	2015