

Liheng Cai

Associate Professor and Copenhaver Fellow, University of Virginia

Materials Science & Engineering | Chemical Engineering | Biomedical Engineering | Chemistry
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❖ PROFESSIONAL APPOINTMENTS

- 06/2025–present Associate Professor, Departments of Materials Science & Engineering and Chemical Engineering; courtesy appointments in Biomedical Engineering and Chemistry, **University of Virginia**
- 06/2025–present Copenhaver Fellow, School of Engineering and Applied Science, **University of Virginia**
- 01/2018–06/2025 Assistant Professor, Departments of Materials Science & Engineering and Chemical Engineering, **University of Virginia**; courtesy appointments in Biomedical Engineering (01/2019–06/2025) and Chemistry (08/2024–06/2025)

❖ EDUCATION AND TRAINING

- 2013–2017 Postdoctoral Fellow, School of Engineering and Applied Sciences & School of Public Health, **Harvard University**. Mentors: David A. Weitz and Jeffrey J. Fredberg
- 2012–2013 Postdoctoral Researcher, Department of Chemistry and Marsico Lung Institute, School of Medicine, **University of North Carolina at Chapel Hill**. Mentors: Michael Rubinstein and Richard C. Boucher
- 2012 Ph.D., Materials Science, **University of North Carolina at Chapel Hill**. Advisor: Michael Rubinstein. Thesis: *Structure and Function of Airway Surface Layer of the Human Lungs & Mobility of Probe Particles in Complex Fluids*
- 2006 B.S., Physics (*highest honor*), **Lanzhou University**, China

❖ HONORS AND AWARDS

- 2026 John H. Dillon Medal, American Physical Society
- 2025 Presidential Early Career Award for Scientists and Engineers (PECASE) (NSF)
- 2025 Copenhaver Fellow, School of Engineering and Applied Science, University of Virginia
- 2024 NIH Maximizing Investigators' Research Award (MIRA, R35)
- 2024 ACS PMSE Early Investigator Award
- 2023 UVA Research Excellence Award (sole recipient from UVA Engineering)
- 2023 *ACS Polymers Au* Rising Star
- 2022 UVA Research Communications Fellow
- 2021 *Soft Matter* Emerging Investigator
- 2020 ACS Petroleum Research Fund Doctoral New Investigator Award
- 2019 National Science Foundation CAREER Award
- 2014 Harvard University Postdoctoral Award for Professional Development
- 2013 North Carolina Impact Award (best Ph.D. research)
- 2012 NSF Fellowship, Boulder Soft Condensed Matter Summer School
- 2012 Invited Student Speaker, Gordon Research Conference: Cilia, Mucus & Mucociliary Interactions

2011	NSF Fellowship, Kavli Institute for Theoretical Physics, University of California, Santa Barbara
2004	Chun-Tsung Scholar, Hui-Chun Chin and Tsung-Dao Lee Chinese Undergraduate Research Endowment (CURE)

❖ RESEARCH PROFILE AND IMPACT

Research theme. My laboratory establishes architecture, from molecular topology and dynamic connectivity to mesoscale organization, as a design variable that governs the mechanics, dynamics, transport, and biological function of soft matter. We integrate polymer physics, synthesis, theory, advanced characterization, and additive manufacturing to establish physical principles, programmable material platforms, and biomaterials across scales, and we translate them to problems in human health, energy, and sustainability. Complementary expertise includes cell biology, nonlinear fluid dynamics, macro-/micro-rheology, microfluidics, advanced characterization, microscopy and image analysis, and *in vivo* studies; an emerging direction couples architecture-encoded polymer design with data-driven, self-driving-lab approaches. The program spans five connected areas, from physical principles (1–2) to biomaterials, manufacturing platforms, and biology (3–5).

1. **Macromolecular architecture and emergent mechanics.** Discovered foldable bottlebrush polymers [*Macromolecules* 2023, front cover; *Macromolecules* 2025, theory] and networks [*Science Advances* 2024, front cover]; introduced entanglement-free bottlebrush networks [*Adv. Mater.* 2015, front cover, >290 citations; *ACS Macro Lett.* 2019; *Soft Matter* 2020] and later showed that bottlebrushes can be highly entangled [*Adv. Mater.* 2026]; developed the first molecular theory [*Macromolecules* 2013, >460 citations] and experimental validation [*Adv. Mater.* 2017, front cover, >540 citations] of tough self-healing polymers; established architecture-based strategies to decouple stiffness and extensibility, control self-assembly [*ACS Macro Lett.* 2026], and enable soft solid-state polymer electrolytes [*Macromolecules* 2026].
2. **Associative polymers and polymer dynamics.** Established that the density and placement of reversible bonds, not bond lifetime alone, govern relaxation and viscoelasticity; introduced a renormalized Rouse framework [*Phys. Rev. Lett.* 2023, front cover, Editors' Suggestion, *Physics Synopsis*] and identified when and why the sticky Rouse model applies [*Science Advances* 2026]; developed the Cai–Panyukov–Rubinstein framework for nanoparticle diffusion in polymer liquids [*Macromolecules* 2011, >450 citations; *Macromolecules* 2015, >330 citations].
3. **Architecture-encoded biomaterials.** Translated bottlebrush architecture into biomaterials whose mechanics, assembly, and transport are set by molecular design: stretchable PEG hydrogels and elastomers for light-based printing [*Adv. Mater.* 2026, back cover], supramolecular bottlebrush hydrogels assembled through architecture-enhanced π – π stacking [*ACS AMI* 2026], and PEG nanocarriers that cross human airway epithelium via architecture-enhanced endocytosis [*ACS Nano* 2024]. Ongoing work, supported by NIH MIRA, Breakthrough T1D, the Coulter Foundation, and UVA LaunchPad for Diabetes, extends these platforms to implantable and injectable biomaterials and targeted drug delivery.
4. **Voxelated bioprinting and additive manufacturing of soft matter.** Introduced and demonstrated voxelated bioprinting, using viscoelastic bio-ink droplets as modular building blocks to program heterogeneous 3D tissue mimics [*Adv. Funct. Mater.* 2022, front cover; *Acta Biomater.* 2023; *Nature Commun.* 2024] and to probe how the spatial organization of cells directs angiogenesis [*Microfluid. Nanofluid.* 2026]; developed all-aqueous microfluidic fabrication of microcapsules and hydrogel microfibers [*Angew. Chem.* 2016, >130 citations; *Lab Chip* 2026]; developed direct-ink-write, stereolithography, and hybrid printing platforms for soft stretchable polymers and composites [*Chem. Mater.* 2021, front cover, Editors' Choice in *Science*; *ACS Polym. Au* 2024; *ACS Appl. Polym. Mater.* 2025; *Adv. Mater. Technol.* 2026].
5. **Soft matter in airway defense and transport.** Co-discovered the periciliary brush (gel-on-brush model) that underlies airway mucus clearance [*Science* 2012, front cover, >1,130 citations; *PNAS* 2018]; developed *in vitro* airway models with tissue-matched stiffness [*AJP-Lung* 2024]; and showed that mucus elasticity promotes directional transport of *Pseudomonas aeruginosa* in native human airway mucus [*Soft Matter* 2026].

Summary of Research, Mentoring, and Teaching

- **Publications:** 47 papers published or in press (35 from UVA, 27 as corresponding author from my independent laboratory) in, e.g., *Science*, *Science Advances*, *PNAS*, *Physical Review Letters*, *Nature Communications*, *Advanced Materials*, *ACS Nano*, and *Macromolecules*; 5,226 Google Scholar citations (3,198 since 2021); h-index 26; i10-index 39 (October 2026).
- **Research support:** \$6.42M total across 25 awards, including \$5.06M as Lead PI, from NSF, NIH, ACS PRF, Breakthrough T1D, CHRB, VIPC, foundations, and UVA.
- **Invited lectures:** 47 invited lectures since joining UVA (including 2 scheduled), at, e.g., Harvard (2), MIT (2), Stanford, UC Berkeley (2), Princeton, Gordon Research Conferences (2), Toronto, Duke, UCSD, UMass Amherst, Wisconsin, APS, ACS, Society of Rheology, and the World Biomaterials Congress, spanning four areas: bottlebrush polymers and networks, associative polymer dynamics, voxelated bioprinting, and soft matter approaches to human lung defense.
- **Intellectual property:** 1 U.S. patent issued; 8 published U.S. and PCT patent applications; additional applications pending.
- **Mentoring:** 13 Ph.D. students (6 graduated, 7 current); 6 postdoctoral researchers (3 to faculty positions, 2 to industry, 1 current); 5 master's students (3 graduated to industry); 23 undergraduate and high-school researchers (4 to graduate school); 7 visiting scholars/students. Ph.D. alumni hold positions at Yale, the University of Minnesota, the Naval Research Laboratory (NRC Research Associateship), and UT Southwestern Medical Center, in clinical medicine (physician-scientist track), and as a startup founder.
- **Trainee achievements:** >30 oral and >20 poster presentations at national, international, and regional meetings; >25 awards and fellowships, including a 2026 APS Frank J. Padden, Jr. Award finalist (Baiqiang Huang) for "Excellence in Polymer Physics Research."
- **Teaching:** Developed the graduate course *Polymer Physics* (MSE 4220/6220) and co-developed the undergraduate course *Science of Cooking* (MSE 2300); co-developed the Concentration in Polymers and Soft Matter for MSE.
- **Service and leadership:** Led the 10-year soft (bio)materials growth strategy for UVA MSE; executive/steering committee, UVA Center for Advanced Biomanufacturing; founder, UVA Squishy Materials Seminar Series (2018–present); organizer or chair at APS (2022–2025), Society of Rheology (2021), World Biomaterials Congress (2024), Soft Matter Triptych (2026), and Virginia Soft Matter Workshop (2019); guest editor for *Soft Matter* and *Frontiers in Physics*; reviewer and panelist for NSF, NIH, DOE-BES, ACS PRF, NASA, and Canadian agencies and ~20 manuscripts per year for >10 journals.

❖ SELECTED RESEARCH SUPPORT

\$6.42M in total research funding across 25 awards, including \$5.06M as Lead PI.

- NIH NIGMS Maximizing Investigators' Research Award (MIRA, R35), PI, 2024–2029. *Constructing 3D voxelated tissues with molecular architecture encoded modular biomaterials.*
- NSF DMR Polymers, PI, 2025–2028. *Foldable bottlebrush polymers.*
- NSF CBET, PI, 2023–2026. *All-aqueous printing of viscoelastic droplets in 3D space.*
- NSF CAREER (DMR), PI, 2020–2025. *Adaptive photonic polymers.*
- ACS Petroleum Research Fund Doctoral New Investigator Award, PI, 2020–2023. *Architecturally designed block copolymers.*
- Breakthrough T1D (formerly JDRF), PI, 2022–2023. *Encapsulation technology for type 1 diabetes.*

Additional support from the Virginia Innovation Partnership Corporation, Virginia Commonwealth Health Research Board, Virginia Catalyst Foundation, Coulter Foundation, UVA LaunchPad for Diabetes, and other UVA programs.

❖ PUBLICATIONS

47 published or in press; 5,226 Google Scholar citations (3,198 since 2021); *h*-index 26; *i10*-index 39 (October 2026). Citation counts (Google Scholar) are shown for papers with ≥ 100 citations.

† Equal contribution; + undergraduate researcher; * corresponding author; underline, Cai lab trainee.

Research areas: Polymers and Soft Matter (PSM); Advanced (Bio)Manufacturing (ABM); Biomaterials (BM); Bioengineering (BE); emerging: Self-Driving Lab/Machine Learning (SDL/ML).

Google Scholar: <https://scholar.google.com/citations?user=rxHv2FQAAAAJ>

Independent career at the University of Virginia — published or in press (35)

1. P. Zhang, M.K. Ramasubramanian, **L.-H. Cai***. Spatial distribution and density of fibroblasts determine angiogenic response of endothelial cells. *Microfluidics and Nanofluidics* (2026). doi:10.1007/s10404-026-02939-3 [BM; BE]
2. X. Ma†, B. Huang†, J. Zhu, K.U. Lao, **L.-H. Cai***. Architecture-driven supramolecular assembly in bottlebrush hydrogels. *ACS Applied Materials & Interfaces* (2026). doi:10.1021/acsami.6c12705 [BM; PSM; Experiment + Theory]
3. M. Kim†, S. Patil†, B. Huang†, R. Kuphal, P. Wąsik, E. Gann, L. Wiegart, C. Fang*, S. Cheng*, **L.-H. Cai***. Bottlebrush architecture suppresses crystallization to enable soft, stretchable solid-state polymer electrolyte for lithium-metal batteries. *Macromolecules* (2026). doi:10.1021/acs.macromol.6c01264 [PSM]
4. S.R. Bajgiran†, E. Oduro†, D.A. Rau†, **L.-H. Cai***. Hybrid additive manufacturing of highly stretchable bottlebrush polymer nanocomposites by decoupled extrusion and photopatterning. *Advanced Materials Technologies* e71288 (2026). doi:10.1002/admt.71288 [ABM]
5. B. Huang, H. Wang, P. Wąsik, E. Gann, **L.-H. Cai***. Interfacial penetration drives anomalous domain spacing in strongly segregated linear-bottlebrush copolymers. *ACS Macro Letters* 15, 1222–1227 (2026). [PSM]
6. M. Kim†, B. Huang†, S. Cheng, **L.-H. Cai***. Highly entangled bottlebrush polymer networks. *Advanced Materials* 38, e73765 (2026). [PSM]
7. M. Kim†, S. Patil†, L. Wiegart, S. Cheng*, **L.-H. Cai***. Associative polymers with controlled sticker placement: How reversible bond distribution and density govern polymer dynamics. *Science Advances* 12, eac4474 (2026). [PSM; Experiment + Theory]
8. J. Zhu†, Y. He†, J. Wang†, I. Powell+, P. Zhang, A. Ouertani+, Y. Wang, **L.-H. Cai***. Clog-free all-aqueous microfluidic fabrication of hydrogel microfibers governed by a universal scaling law. *Lab on a Chip* 26, 345–352 (2026). [BM; Experiment + Theory]
9. R. Dickson, Z.-J. He, **L.-H. Cai***. Elasticity promotes directional transport of *Pseudomonas aeruginosa* in native human airway mucus and complex fluids. *Soft Matter* 22, 485–496 (2026). Themed Collection celebrating Michael Rubinstein's 70th birthday. [BE]
10. B. Huang, M. Kim, P. Zhang, E. Oduro, D.A. Rau, **L.-H. Cai***. Additive manufacturing of molecular architecture encoded stretchable polyethylene glycol hydrogels and elastomers. *Advanced Materials* 38, e12806 (2026). Back cover; news report. [ABM; PSM; BM]
11. D.A. Rau†, M. Kim†, B. Xu, **L.-H. Cai***. Vat photopolymerization printing of modular soft stretchable low-cost elastomers. *ACS Applied Polymer Materials* 7, 7566–7574 (2025). [ABM; PSM]
12. **L.-H. Cai***. Molecular structure of foldable bottlebrush polymers in melts. *Macromolecules* 58, 4320–4339 (2025). [PSM; Theory]
13. B. Huang, S. Nian, **L.-H. Cai***. A universal strategy for decoupling stiffness and extensibility of polymer networks. *Science Advances* 10, eadq3080 (2024). Front cover; news report. [PSM; Experiment + Theory]

14. Z.-J. He[†], B. Huang[†], **L.-H. Cai**^{*}. Bottlebrush polyethylene glycol nanocarriers translocate across human airway epithelium via molecular architecture-enhanced endocytosis. *ACS Nano* 18, 17586–17599 (2024). News report. [BE; BM; Experiment + Theory]
15. J. Zhu, Y. He, Y. Wang, **L.-H. Cai**^{*}. Voxelated bioprinting of modular double-network bio-ink droplets. *Nature Communications* 15, 5902 (2024). News report. [ABM; BE; BM; Experiment + Theory]
16. Z.-J. He[†], C. Chu[†], R. Dickson, K. Okuda, **L.-H. Cai**^{*}. A gel-coated air-liquid-interface culture system with tunable substrate stiffness matching healthy and diseased lung tissues. *American Journal of Physiology – Lung Cellular and Molecular Physiology* 326, L292–L302 (2024). [BE]
17. M. Kim[†], S. Nian[†], D.A. Rau[†], B. Huang, J. Zhu, G. Freychet, M. Zhernenkova, **L.-H. Cai**^{*}. 3D printable modular soft elastomers from physically crosslinked homogeneous associative polymers. *ACS Polymers Au* 4, 98–108 (2024). 2023 Virtual Issue of Rising Stars in Polymers. [ABM; PSM]
18. S. Nian[†], S. Patil[†], S. Zhang, M. Kim, Q. Chen, M. Zhernenkova, T. Ge, S. Cheng^{*}, **L.-H. Cai**^{*}. Dynamics of associative polymers with high density of reversible bonds. *Physical Review Letters* 130, 228101 (2023). Front cover; Editors' Suggestion; highlighted by a Synopsis in *Physics*; reported by EurekaAlert and others. [PSM; Theory + Experiment]
19. S. Nian[†], B. Huang[†], G. Freychet, M. Zhernenkova, **L.-H. Cai**^{*}. Unexpected folding of bottlebrush polymers in melts. *Macromolecules* 56, 2551–2559 (2023). Front cover. [PSM; Theory + Experiment]
20. J. Zhu, **L.-H. Cai**^{*}. All-aqueous printing of viscoelastic droplets in yield-stress fluids. *Acta Biomaterialia* 165, 60–71 (2023). [ABM; Theory + Experiment]
21. S. Nian, **L.-H. Cai**^{*}. Dynamic mechanical properties of self-assembled bottlebrush polymer networks. *Macromolecules* 55, 8058–8066 (2022). [PSM; Theory + Experiment]
22. D. Koveal, P.C. Rosen, D.J. Meyer, C.M. Díaz-García, Y. Wang, **L.-H. Cai**, P. Chou, D.A. Weitz, G. Yellen. A high-throughput multiparameter screen for accelerated development and optimization of soluble genetically encoded fluorescent biosensors. *Nature Communications* 13, 2919 (2022). >120 citations. [BE]
23. J. Zhu[†], Y. He[†], L. Kong, Z. He, K.Y. Kang⁺, S.P. Grady⁺, L.Q. Nguyen⁺, D. Chen, Y. Wang, J. Oberholzer, **L.-H. Cai**^{*}. Digital assembly of spherical viscoelastic bio-ink particles. *Advanced Functional Materials* 32, 2109004 (2022). Front cover; reported by EurekaAlert. [ABM; BE]
24. S. Nian, Z. Fan, G. Freychet, M. Zhernenkova, S. Redemann, **L.-H. Cai**^{*}. Self-assembly of flexible linear–semiflexible bottlebrush–flexible linear triblock copolymers. *Macromolecules* 54, 9361–9371 (2021). [PSM]
25. S. Nian[†], J. Zhu[†], H. Zhang, Z. Gong, G. Freychet, M. Zhernenkova, B. Xu, **L.-H. Cai**^{*}. Three-dimensional printable, extremely soft, stretchable, and reversible elastomers from molecular architecture-directed assembly. *Chemistry of Materials* 33, 2436–2445 (2021). Front cover; Editors' Choice in *Science*; reported by EurekaAlert and others. [PSM; ABM]
26. Y. Shen, H. Wu, P.J. Lu, D. Wang, M. Shayegan, H. Li, W. Shi, Z. Wang, **L.-H. Cai**, J. Xia, M. Zhang, R. Ding, H. Herrmann, R. Goldman, F.C. MacKintosh, A. Moncho-Jorda, D.A. Weitz. Effects of vimentin intermediate filaments on the structure and dynamics of *in vitro* multicomponent interpenetrating cytoskeletal networks. *Physical Review Letters* 127, 108101 (2021). [BE]
27. J. Xia, **L.-H. Cai**, H. Wu, F.C. MacKintosh, D.A. Weitz. Anomalous mechanics of Zn²⁺-modified fibrin networks. *Proceedings of the National Academy of Sciences* 118, e2020541118 (2021). [BE]
28. Y. Wang, T. Cao, J. Ko, Y. Shen, W. Zong, K. Sheng, W. Cao, S. Sun, **L.-H. Cai**, Y.-L. Zhou, X.-X. Zhang, C. Zong, R. Weissleder, D.A. Weitz. Dissolvable polyacrylamide beads for high-throughput droplet DNA barcoding. *Advanced Science* 7, 1903463 (2020). [BE]
29. **L.-H. Cai**^{*}. Molecular understanding for large deformations of soft bottlebrush polymer networks. *Soft Matter* 16, 6259–6264 (2020). Emerging Investigator Issue; Editor's Choice. [PSM; Theory + Experiment]

30. Y. Zhang, M. Yin, Y. Baek, K. Lee, G. Zangari, **L.-H. Cai**, B. Xu. Capillary transfer of soft films. *Proceedings of the National Academy of Sciences* 117, 5210–5216 (2020). [PSM]
31. X.Z. Wang, C.J. Yang, **L.-H. Cai***, D. Chen*. The rheology property of organogels based on 3D helical nanofilament networks self-assembled by bent-core liquid crystals. *Acta Physica Sinica* 69, 086102 (2020). [PSM]
32. R. Ding, K.-H. Hung, A. Mitra, L. Ung, D. Lightwood, R. Tu, D. Starkie, **L.-H. Cai**, L. Mazutis, S. Chong, D.A. Weitz, J. Heyman. Rapid isolation of antigen-specific B-cells using droplet microfluidics. *RSC Advances* 10, 27006–27013 (2020). [BE]
33. S. Nian, H. Lian, Z. Gong, M. Zhernenkov, J. Qin, **L.-H. Cai***. Molecular architecture directs linear-bottlebrush-linear triblock copolymers to self-assemble to soft, reprocessable elastomers. *ACS Macro Letters* 8, 1528–1534 (2019). [PSM]
34. B. Haney, D. Chen, **L.-H. Cai**, D.A. Weitz, S. Ramakrishnan. Millimeter-size Pickering emulsions stabilized with Janus micro-particles. *Langmuir* 35, 4693–4701 (2019). [PSM]
35. B. Button, H. Goodell, E. Atieh, Y.-C. Chen, R. Williams, S. Shenoy, E. Lackey, N. Shenkute, **L.-H. Cai**, R. Dennis, R. Boucher, M. Rubinstein. Roles of mucus adhesion and cohesion in cough clearance. *Proceedings of the National Academy of Sciences* 115, 12501–12506 (2018). >140 citations. [BE]

Prior to the University of Virginia — published (12)

36. D. Chen, E. Amstad, C. Zhao, **L.-H. Cai**, J. Fan, Q. Chen, M. Hai, S. Koehler, H. Zhang, F. Liang, Z. Yang, D.A. Weitz. Biocompatible amphiphilic hydrogel-solid dimer particles as colloidal surfactants. *ACS Nano* 11, 11978–11985 (2017). [PSM]
37. J. Wu, **L.-H. Cai***, D.A. Weitz*. Tough self-healing elastomers by molecular enforced integration of covalent and reversible networks. *Advanced Materials* 29, 1702616 (2017). Cover article; reported by Harvard News; >540 citations. [PSM]
38. W. Xing, H. Li, G. Huang*, **L.-H. Cai***, J. Wu*. Graphene oxide induced crosslinking and reinforcement of elastomers. *Composites Science and Technology* 144, 223–229 (2017). >120 citations. [PSM]
39. Y. Qin, Y. Hu, S.A. Koehler, **L.-H. Cai**, J. Wen, X. Tan, W.L. Xu, Q. Sheng, X. Hou, J. Xue, M. Yu, D.A. Weitz. Ultrafast nanofiltration through large-area single-layered graphene membranes. *ACS Applied Materials & Interfaces* 9, 9239–9244 (2017). [PSM]
40. L. Zhang†, **L.-H. Cai†**, P.S. Lienemann, T. Rossow, I. Polenz, M. Ehrbar, H. Na, D. Mooney, D.A. Weitz. One-step microfluidic fabrication of polyelectrolyte microcapsules in aqueous conditions for protein release. *Angewandte Chemie International Edition* 55, 13470–13474 (2016). >130 citations. [BE]
41. **L.-H. Cai**, T.E. Kodger, R.E. Guerra, A.F. Pegoraro, M. Rubinstein, D.A. Weitz. Soft poly(dimethylsiloxane) elastomers from architecture-driven entanglement free design. *Advanced Materials* 27, 5132–5140 (2015). Cover article; reported by Harvard News and ScienceDaily; >290 citations. [PSM]
42. **L.-H. Cai**, S. Panyukov, M. Rubinstein. Hopping diffusion of nanoparticles in polymer matrices. *Macromolecules* 48, 847–862 (2015). >330 citations. [PSM; Theory]
43. A.G. Henderson, C. Ehre, B. Button, L.H. Abdullah, **L.-H. Cai**, M.W. Leigh, G. DeMaria, H. Matsui, S.H. Donaldson, C.W. Davis, J.K. Sheehan, R.C. Boucher, M. Kesimer. Cystic fibrosis airway secretions exhibit mucin hyperconcentration and increased osmotic pressure. *Journal of Clinical Investigation* 124, 3047–3060 (2014). >420 citations. [BE]
44. E.B. Stukalin†, **L.-H. Cai†**, N.A. Kumar, L. Leibler, M. Rubinstein. Self-healing of unentangled polymer networks with reversible bonds. *Macromolecules* 46, 7525–7541 (2013). >460 citations. [PSM; Theory]
45. B. Button†, **L.-H. Cai†**, C. Ehre, M. Kesimer, D.B. Hill, J.K. Sheehan, R.C. Boucher, M. Rubinstein. A periciliary brush promotes the lung health by separating the mucus layer from airway epithelia. *Science* 337,

937–941 (2012). Front cover; highlighted by a *Perspective*; reported by BBC, *U.S. News & World Report*, and others; >1,130 citations. [BE]

46. **L.-H. Cai**, S. Panyukov, M. Rubinstein. Mobility of nonsticky nanoparticles in polymer liquids. *Macromolecules* 44, 7853–7863 (2011). >450 citations. [PSM; Theory]
47. D. Zhou, **L.-H. Cai**, F.-S. Wen, F.-S. Li. Template synthesis and magnetic behavior of FeNi alloy nanotube arrays. *Chinese Journal of Chemical Physics* 20, 821 (2007).

Manuscripts under review or in preparation: 4 submitted or in revision; 8 in preparation.

Book chapter and editorials

1. J. Wu*, **L.-H. Cai***, H. Wang*. Advanced materials for self-healing applications. In *Design, Fabrication, Properties and Applications of Smart and Advanced Materials*, p. 308 (2016). [PSM]
2. **L.-H. Cai***, S. Datta*, X. Cheng*. Active matter in complex environments. Editorial, *Frontiers in Physics* 10, 1005146 (2022).
3. K. Wang, **L.-H. Cai**, B. Lan, J.J. Fredberg. Hidden in the mist no more: Physical force in cell biology. *Nature Methods* 13, 124–125 (2016).

❖ PATENTS AND INTELLECTUAL PROPERTY

1 U.S. patent issued; 8 published U.S. and PCT patent applications; additional applications pending.

Issued

1. **L.-H. Cai**, J. Zhu. Digital assembly of spherical hydrogel voxels to form 3D lattice structures. U.S. Patent No. 12,496,767 (issued December 16, 2025).

Published U.S. and PCT patent applications

2. **L.-H. Cai**, D.A. Rau, M. Kim. Resin compositions, polymers made from the resin composition, methods of making the polymer, and methods and systems of making structures that include the polymer. U.S. Application No. 19/217,343; filed May 23, 2025.
3. **L.-H. Cai**, B. Huang. Foldable bottlebrush polymers, foldable bottlebrush polymer networks, and method of making foldable bottlebrush polymers and networks. U.S. Application No. 19/217,358; filed May 23, 2025.
4. **L.-H. Cai**, Z.-J. He, B. Huang. Bottlebrush polyethylene glycol nanocarriers. PCT/US2025/013617; filed January 29, 2025 (priority January 30, 2024; U.S. Provisional 63/626,879).
5. **L.-H. Cai**, B. Huang, S. Nian. Polymers, polymer networks, and methods of making polymer networks. PCT/US24/40656; filed August 2, 2024.
6. **L.-H. Cai**, Z.-J. He, C. Chu. A gel-coated air-liquid-interface culture system with tunable substrate stiffness matching healthy and diseased lung tissues. U.S. Application No. 18/623,437; filed April 2, 2024 (priority July 5, 2023).
7. **L.-H. Cai**, S. Nian. Intrinsically reprocessable double-network elastomers. PCT/US2023/23566; filed May 25, 2023; international application November 22, 2024.
8. **L.-H. Cai**, J. Zhu. Method and system for all-aqueous printing of viscoelastic droplets in yield-stress fluids and related compositions thereof. PCT/US2023/067234 (priority May 19, 2022).
9. **L.-H. Cai**, S. Nian, J. Zhu. Ultrasoft, stretchable, reversible elastomers for direct-write printing deformable structures. PCT/US2021/028987; filed April 23, 2021.

❖ INVITED LECTURES AND SEMINARS

47 invited lectures since joining UVA in 2018 (including 2 scheduled), spanning four areas: (i) bottlebrush polymers and networks, (ii) associative polymer dynamics, (iii) voxelated bioprinting, and (iv) soft matter approaches to human lung defense. Earlier lectures (2017) listed at end.

51. 04/2027 Princeton Materials Institute / Princeton Center for Complex Materials Seminar Series, Princeton University. *Encoding function in soft (bio)materials across scales* (scheduled)
50. 10/2026 Society of Rheology Annual Meeting, Boston, MA. *Rethinking associative polymer dynamics: Decoupling relaxation time and viscoelastic spectra* (scheduled)
49. 07/2026 **Gordon Research Conference: Polymer Physics**, Mount Holyoke College, South Hadley, MA. *Bottlebrush polymer networks and hydrogels*
48. 06/2026 26th Polymer Networks Group Meeting, Dresden, Germany. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
47. 03/2026 APS Global Physics Summit, Denver, CO. *Physics of architecturally complex polymers and networks*
46. 02/2026 **Gordon Research Conference: Colloidal, Macromolecular and Polyelectrolyte Solutions**, Ventura, CA. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
45. 02/2026 Department of Chemical and Biological Engineering, University of Wisconsin–Madison. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
44. 12/2025 Institute of Chemical Physics, Chinese Academy of Sciences, Beijing (online). *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
43. 12/2025 Macromolecules Innovation Institute, Virginia Tech. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
42. 11/2025 Department of Chemistry, University of Toronto. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
41. 11/2025 AIChE Annual Meeting, Boston, MA. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
40. 10/2025 Department of Chemical and Biomolecular Engineering, University of California, Berkeley. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
39. 04/2025 Program in Polymers and Soft Matter (PPSM) Seminar Series, MIT. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
38. 04/2025 Department of Mechanical Engineering, MIT. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
37. 03/2025 Department of Chemical and Nano Engineering, University of California, San Diego. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
36. 03/2025 ACS Polymer Chemistry Prize Symposium, ACS Spring Meeting, San Diego, CA. *Bottlebrush polymers, networks, and devices*
35. 03/2025 Stanford Polymer Collective Seminar Series, Stanford University. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
34. 03/2025 Department of Materials Science and Engineering, University of California, Berkeley. *Bottlebrush polymers, networks, and devices*
33. 03/2025 Departments of Chemical Engineering and Biomedical Engineering, UMass Amherst. *Bottlebrush polymers, networks, biomaterials, and tissue mimics*
32. 02/2025 Department of Materials Science and Engineering, Boston University. *Bottlebrush polymers, networks, and devices*

31. 02/2025 Department of Chemical and Biomolecular Engineering, North Carolina State University. *Bottlebrush polymers, networks, and devices*
30. 12/2024 Squishy Physics Seminar Series, Harvard University. *Bottlebrush polymers, networks, and devices*
29. 12/2024 Department of Biomedical Engineering, Tufts University. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
28. 10/2024 Department of Chemistry, Duke University. *Bottlebrush polymers, networks, and devices*
27. 10/2024 Department of Polymer Science and Engineering, UMass Amherst. *Bottlebrush polymers, networks, and devices*
26. 09/2024 Department of Physics, Virginia Commonwealth University. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
25. 06/2024 **He Bin-Ling Lectureship**, Nankai University, China. *Bottlebrush polymers, networks, and devices*
24. 05/2024 World Biomaterials Congress, Daegu, South Korea. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
23. 04/2024 Department of Physics, University of Virginia. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
22. 03/2024 APS March Meeting, Minneapolis, MN. *Bottlebrush polymers, networks, and devices*
21. 12/2023 97th New England Complex Fluids Workshop, Harvard University. *Bottlebrush polymers, networks, and devices*
20. 09/2023 Department of Chemical Engineering and Materials Science, Michigan State University. *Bottlebrush polymers, networks, and devices*
19. 04/2023 9th Virginia Soft Matter Workshop, Virginia Commonwealth University. *Bottlebrush polymers, networks, and devices*
18. 12/2022 Department of Chemical and Biological Engineering, Drexel University. *Bottlebrush polymers, networks, and devices*
17. 11/2022 Department of Physics, James Madison University. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
16. 10/2022 Department of Biomedical Engineering, University of Illinois Chicago. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
15. 09/2022 Self-Assembly of Soft Materials Symposium, Los Alamos National Laboratory. *Voxelated bioprinting: Digital assembly of viscoelastic bio-ink droplets*
14. 03/2022 Department of Biochemistry and Molecular Genetics, University of Virginia. *Biophysical cues on human lung defense: From airway remodeling to mucosal drug delivery*
13. 10/2021 Annual Meeting of the Society of Rheology. *Reprocessable, soft, 3D printable elastomers*
12. 08/2021 Department of Bioengineering, University of Maryland. *Biophysical cues on human lung defense: From airway remodeling to mucosal drug delivery*
11. 05/2021 IUTAM Symposium on Mechanics of Smart and Tough Gels. *Adaptive soft materials from sequence-controlled polymer assembly*
10. 04/2021 Department of Physics, Hunter College, CUNY. *Biophysical cues on human lung defense: From airway remodeling to mucosal drug delivery*
9. 11/2020 Soft Condensed Matter and Physics of Living Systems, School of Physics, Georgia Institute of Technology. *Biophysical cues on human lung defense: From airway remodeling to mucosal drug delivery*

8. 04/2019 Rubber Division, ACS 195th Technical Meeting, Independence, OH. *Tough, self-healing elastomers*
7. 04/2019 Bridgestone Americas Technology Center, Akron, OH. *Tough, self-healing elastomers*
6. 04/2019 ExxonMobil Clinton Research Center, Annandale, NJ. *Tough, self-healing elastomers*
5. 02/2018 Marsico Lung Institute, University of North Carolina at Chapel Hill. *Human airway epithelial responses to chronic pathological osmotic stress*
4. 11/2017 Institute of Physics, Chinese Academy of Sciences, Beijing. *Polymer science as a tool for materials design and biological discoveries*
3. 11/2017 Department of Chemistry, Peking University, Beijing. *Polymer science as a tool for materials design and biological discoveries*
2. 11/2017 Institute of Chemistry, Chinese Academy of Sciences, Beijing. *Polymer science as a tool for materials design and biological discoveries*
1. 11/2017 Department of Chemical Engineering, Tsinghua University, Beijing. *Polymer science as a tool for materials design and biological discoveries*

❖ MENTORING

Mentored 13 Ph.D. students (6 graduated), 6 postdoctoral researchers, 5 master's students, 23 undergraduate and high-school researchers, and 7 visiting scholars/students. Three former postdoctoral researchers hold faculty positions; Ph.D. graduates have advanced to research positions at leading universities, a national laboratory, an academic medical center, clinical medicine, and entrepreneurship. Trainees have received >25 awards and fellowships.

Trainees have given 34 oral and 24 poster presentations at national and international meetings, including APS, ACS, AIChE, Gordon Research Conferences, ATS, and the International Soft Matter Conference (see Appendix).

Doctoral students (13 total: 6 graduated, 7 current)

#	Name	Dept.	Years	Status / placement
13	Yulun Wu	MSE	2025–	Ph.D. student; Olsen Fellowship
12	Jingwei Tang	MSE	2025–	Ph.D. student
11	Ning Ran	ChE	2024–	Ph.D. student
10	Sara Olsen	ChE	2024–	Ph.D. student; UVA Presidential and Gainer Fellowships
9	Weining (Winne) Zhang	MSE	2024–	Ph.D. student
8	Emmanuel Oduro	MSE	2023–	Ph.D. student
7	Xiaoxiao Ma	MSE	2022–	Ph.D. student
6	Baiqiang Huang (Ph.D.)	MSE	2021–2026	Postdoctoral researcher, Chemical Engineering, University of Minnesota; 2026 APS Padden Award finalist
5	Myoeum Kim (Ph.D.)	MSE	2021–2026	NRC Research Associateship, U.S. Naval Research Laboratory
4	Jinchang Zhu (Ph.D.)	MSE	2020–2026	Postdoctoral researcher, Developmental Biology, Yale University
3	Pu (Bruce) Zhang (Ph.D.)	MAE	2019–2025	Startup founder; co-advised with M.K. Ramasubramanian
2	Riley Dickson (Ph.D.)	ChE	2020–2025	Senior Research Associate, UT Southwestern Medical Center
1	Zhijian He (M.D., Ph.D.)	BME	2019–2024	Internal Medicine Residency, AdventHealth Orlando (physician-scientist track)

Ph.D. dissertations supervised (6)

1. **Myoeum Kim** (Ph.D., MSE, 2026). “Associative Polymers: Molecular Design, Dynamics, Mechanics, and Applications.” Now: NRC Research Associate, U.S. Naval Research Laboratory.
2. **Baiqiang Huang** (Ph.D., MSE, 2026). “Bottlebrush Polymers, Networks, and Applications.” Now: Postdoctoral researcher, Chemical Engineering, University of Minnesota.
3. **Jinchang Zhu** (Ph.D., MSE, 2026). “Digital Assembly of Spherical Bio-Ink Particles.” Now: Postdoctoral researcher, Developmental Biology, Yale University.
4. **Pu (Bruce) Zhang** (Ph.D., MAE, 2025; co-advised with Melur K. Ramasubramanian). “Engineering Systems for Probing Cell-Matrix and Cell-Cell Interactions.” Now: Startup founder.
5. **Riley Dickson** (Ph.D., ChE, 2025). “Elasticity Promotes Directional Transport of *Pseudomonas aeruginosa* in Native Human Airway Mucus and Complex Fluids.” Now: Senior Research Associate, UT Southwestern Medical Center.
6. **Zhijian He** (M.D., Ph.D., BME, 2024). “Biophysical Cues on Human Lung Defense: From Airway Remodeling to Mucosal Drug Delivery.” Now: Internal Medicine Residency, AdventHealth Orlando (physician-scientist track).

Postdoctoral researchers (6 total: 3 to faculty, 2 to industry, 1 current)

#	Name	Previous institution	Start	End	Placement
6	Xujun Zheng	Duke University	09/2025	03/2026	Professor, Sun Yat-sen University
5	Hepi Hari Susapto	National University of Singapore	03/2025		Current
4	Shahryar Ramezani Bajgiran	Rice University	06/2024	06/2026	Digital Ink Chemist, Nazdar Ink Technologies
3	Daniel A. Rau	Virginia Tech	07/2022	08/2024	Assistant Professor, University of Wyoming
2	Genyu Du	University of Virginia	11/2020	02/2021	Senior Scientist, Hongene Biotech, USA
1	Shifeng Nian	University of Virginia	07/2018	06/2021	Associate Professor, Northwestern Polytechnical University, China

Master’s students (5 advised; 3 graduated, listed below)

#	Name	Dept.	Start	End	Placement
3	Zihao Gong (M.S.)	MSE	01/2018	12/2021	Industry
2	Zhouhao Fan (M.E.)	ChE	08/2020	02/2022	Industry
1	Catherine Chu (M.S.)	MSE	01/2020	07/2022	Process Engineer, TSMC, Arizona

Undergraduate researchers

23 undergraduate, REU, summer, and high-school researchers mentored (4 continued to graduate school). Listed below: undergraduate co-authors of publications or conference presentations.

Name	Major / program	Years	Subsequent position
Will Zheng	MSE, UVA	2025–	
Zoe Benton	MAE, UVA	2023–2025	Ph.D. in ME, Virginia Tech
Alexander Church	ChE, UVA	2023–2025	Ph.D. in ChE, Purdue University
Isabella Powell	Summer Diabetes Research Internship	2021	
Kaylen Kang	BME Capstone, UVA	2020–2021	
Shannon Grady	BME Capstone, UVA	2020–2021	

Name	Major / program	Years	Subsequent position
Leander Nguyen	BME Capstone, UVA	2020–2021	
Anthony Ouertani	ChE, UVA	2018–2020	

Visiting scholars/students (7 total)

#	Name	Home institution	Start	End	Subsequent position
7	Haixiang Tang	Peking University	06/2026	09/2026	Peking University
6	Yuehui Wu	Zhejiang University	10/2020	09/2021	Zhejiang University
5	Zhinan Yang	Sichuan University	08/2019	10/2019	The Chinese University of Hong Kong
4	Bocheng Liu	Zhejiang University	07/2019	08/2019	Zhejiang University
3	Baiqiang Huang	Zhejiang University	07/2019	08/2019	Ph.D. student, University of Virginia (Cai lab)
2	Le Pan	Beihang University	05/2018	08/2018	University of Pennsylvania
1	Zhongwei Ma	Lanzhou University	05/2018	08/2018	Rensselaer Polytechnic Institute

Awards received by trainees

Doctoral students

- 2026 — **APS Frank J. Padden, Jr. Award Finalist**, Baiqiang Huang
- 2026 — **ACS Excellence in Graduate Polymer Research Symposium**, Baiqiang Huang
- 2026 — **ACS POLY Graduate Student Travel Award**, Baiqiang Huang
- 2026 — **NRC Research Associateship Award**, Myoeum Kim
- 2026 — **APS DPOLY Best Poster Award**, Myoeum Kim
- 2025 — **Raven Fellowship**, UVA SEAS, Jinchang Zhu
- 2025 — **Olsen Fellowship**, Yulun Wu
- 2024 — **Presidential Fellowship**, University of Virginia, Sara Olsen
- 2024 — **Chemical Engineering Gainer Fellowship**, University of Virginia, Sara Olsen
- 2024 — **APS DPOLY Short Course Travel Award**, Jinchang Zhu
- 2024 — **2nd place, Oral Presentations**, Chemical Engineering Research Symposium (CHEERS), Riley Dickson
- 2024 — **2nd place, Best Poster Design**, 20th UVA Engineering Research Symposium (UVERS), Riley Dickson
- 2023 — **Doris Kuhlmann-Wilsdorf Outstanding Graduate Student Award**, Jinchang Zhu
- 2023 — **Victor Orphan Graduate Fellowship**, Jinchang Zhu
- 2023 — **3rd place, Best Poster**, 7th Virginia Soft Matter Workshop, Riley Dickson
- 2023 — **American Thoracic Society Abstract Scholarship**, Zhijian He

Postdoctoral researchers

- 2024 — **Climate Fellow**, UVA Environmental Resilience Institute, Shahryar Ramezani Bajgiran
- 2024 — **APS DPOLY Short Course Travel Award**, Daniel A. Rau
- 2024 — **Finalist**, UVA Postdoctoral Lightning Talk Competition, Daniel A. Rau
- 2023 — **Climate Fellow**, UVA Environmental Resilience Institute, Daniel A. Rau
- 2023 — **Best Poster Award**, 7th Virginia Soft Matter Workshop, Daniel A. Rau

Undergraduates

22. 2026 — Dean's Undergraduate Engineering Summer Fellowship, Will Zheng
23. 2024 — Dean's Undergraduate Engineering Summer Fellowship, Zoe Benton
24. 2022 — Best Presentation Award, Summer Diabetes Research Internship, Gabriella Recce
25. 2021 — Summer Diabetes Research Internship, Isabella Powell
26. 2020 — CAD-Bio Summer Research Fellowship, Anthony Ouertani
27. 2020 — Graduated with distinction (magna cum laude) in Chemistry, Sean Lee
28. 2019 — NanoSTAR Summer Research Fellowship, Anthony Ouertani
29. 2019 — Chemistry Undergraduate Research Fellowship, Sean Lee
30. 2018 — NanoSTAR Summer Research Fellowship, Sneha Tara Ravi
31. 2018 — NanoSTAR Summer Research Fellowship, Brandon Phan

❖ TEACHING AND CURRICULUM DEVELOPMENT

Course	Level	Terms taught
MSE 4220/6220 <i>Polymer Physics</i>	Undergraduate/graduate	Fall 2021, 2022, 2024, 2025
ChE 5561 <i>Polymer Physics</i>	Graduate	Spring 2019
MSE 2300 <i>Science of Cooking: From Modern Cuisine to Soft Matter Science</i>	Undergraduate	Fall 2020, 2023
MSE 2090 <i>Introduction to Materials Science</i>	Undergraduate	Spring 2020, 2021, 2023, 2024

Curriculum leadership

- Co-developed the Concentration in Polymers and Soft Matter for the UVA MSE undergraduate program (UVA Education Innovation Award, 2019–2024).
- Developed the graduate course *Polymer Physics* (MSE 4220/6220) and co-developed the undergraduate course *Science of Cooking* (MSE 2300), connecting soft-matter science to hands-on laboratory experiences in a teaching kitchen.

❖ PROFESSIONAL LEADERSHIP AND SERVICE

Institutional and strategic leadership

- | | |
|--------------|---|
| 2020 | Led development of a 10-year growth strategy in soft (bio)materials for UVA MSE (MSE Strategy Planning Committee), presented to the MSE External Review Committee |
| 2020–present | Steering/Executive Committee, UVA Center for Advanced Biomanufacturing |
| 2018–present | Founder, UVA Squishy Materials Seminar Series — the first weekly seminar series in soft matter/biomaterials at UVA |

Department

- | | |
|--------------|---|
| 2023–present | MSE Graduate Admissions Committee |
| 2022–present | MSE Undergraduate Program Committee |
| 2021–present | MSE Undergraduate Curriculum Committee (developed the curriculum for the new B.S. program in MSE) |
| 2021–2022 | ChE Faculty Search Committee |
| 2020 | MSE Ph.D. Qualifying Exam Committee (redesigned the exam format, metrics, and scope) |
| 2019 | MSE Administrator Recruiting Committee |

2018–present Team member, recruiting students from underrepresented groups

School

2019–present SEAS Undergraduate Committee

2019–present Co-developer, Concentration in Polymers and Soft Matter for MSE

Ph.D. dissertation committees (24)

Yiran Wang (ChE, 2019); Qingchang Liu (MAE, 2020); Shunyan Gu (MAE, 2020); John Tomko (MSE, 2020); Xueyin Zhao (ChE, 2021); Yue Zhang (MAE, 2021); Ji Zhang (Chemistry, 2021); Haozhe Zhang (MAE, 2023); Tracy Kuper (ChE, 2024); Julia Tumbic (BME, 2024); Jack Whitewolf (BME, 2024); Kenneth Brown (MAE, 2024); Rhea Braun (ChE, 2024); Cole Love-Baker (MAE, 2024); Alexander Scherschel (MAE, 2025); Ho Lun Chan (MSE, 2025); Sanha Kim (ChE, 2026); Emma Tiernan (MAE); Lucas Kimerer (ChE); Darren Miller (ChE); Ipsita Datta (School of Architecture); Byeongcheol Min (ChE); Ryan Cordier (MAE); Jacob Kenney (ChE).

Scientific community leadership and editorial service

2026 Co-organizer, 2026 Soft Matter Triptych, Duke University

2025–2027 Guest Editor, *Soft Matter* themed collection celebrating Michael Rubinstein's 70th birthday

2025 Co-Chair, Focus Session “Programmable Structures from Responsive Polymers and Soft Matter,” APS Global Physics Summit, Anaheim, CA

2023–2025 Co-Chair, Focus Session “Programmed Responsive Polymers and Soft Matter,” APS March Meeting

2024 Chair, Symposium “Cell Encapsulation and 3D Digital Assembly for Basic and Applied Biomedicine,” World Biomaterials Congress, Daegu, South Korea

2022 Session Chair, Focus Session “Sequence Controlled Polymers,” APS March Meeting

2021–2022 Guest Editor, Research Topic “Active Matter in Complex Environments,” *Frontiers in Physics*

2021 Co-Chair, Innovative Biofabrication Platforms Session, 5th Mid-Atlantic Advanced Biomanufacturing Symposium

2021 Co-Chair, Additive Manufacturing and Composites Session, 92nd Annual Meeting of the Society of Rheology

2019 Co-organizer, 7th Virginia Soft Matter Workshop

Proposal review

NSF Panelist and ad hoc reviewer, Division of Materials Research and Engineering Research Centers program

NIH Ad hoc member: Lung Cellular, Molecular, and Immunobiology (LCMI); Biomaterials and Biointerfaces (BMBI); Bioanalytical, Molecular, Cellular Sciences and Technologies (ZRG1 BCTA-N); Small Business (SBIR/STTR); Instrumentation (S10); special-emphasis panels

DOE Mail-in reviewer, Office of Basic Energy Sciences, including the Early Career Research Program

Other ACS Petroleum Research Fund; NASA; New Frontiers in Research Fund and National Research Council Canada

Journal review

~20 manuscripts per year for >10 journals, including *Nature*, *Nature Materials*, *PNAS*, *Science Advances*, *Advanced Materials* and sister journals, *Macromolecules*, *ACS Macro Letters*, *Small*, *Biophysical Journal*, *Biomacromolecules*, *Soft Matter*, *Materials Horizons*, *Chemical Communications*, *Acta Biomaterialia*, and *Journal of Allergy and Clinical Immunology*.

❖ MEDIA COVERAGE AND OUTREACH

Independent media

- 2023 — APS Physics: [Bond density not strength controls polymer stickiness](#)
- 2021 — Washington Post: [Science of Cooking feature](#)
- 2012 — BBC News: [Coverage of the periciliary brush discovery \(Science 2012\)](#)
- 2012 — U.S. News & World Report: [Human airways' brush mechanism gives clues to lung diseases](#)

Institutional news

- 2025 — UVA Engineering: [From artificial organs to advanced batteries: A breakthrough 3D-printable polymer](#)
- 2025 — UVA Engineering: [UVA Engineering polymer scientist wins American Physical Society's John H. Dillon Medal](#)
- 2025 — UVA Engineering: [Carrigan, Cai named the latest Copenhaver Fellows](#)
- 2025 — UVA Research News: [Engineering hope with 3D printing and soft materials](#)
- 2025 — UVA Engineering: [PECASE winners: 3 UVA Engineering professors receive Presidential Early Career Awards](#)
- 2025 — HOOS IN STEM (video): [An engineering powerhouse: Meet UVA's three presidential honorees](#)
- 2024 — UVA Engineering: [In major materials breakthrough, UVA team solves a nearly 200-year-old challenge in polymers](#)
- 2024 — UVA Engineering: [UVA engineers design lookalike drug carrier to evade lung's lines of defense](#)
- 2024 — UVA Engineering: [UVA Engineering professor lands \\$1.9 million NIH award to maximize biomedical research](#)
- 2024 — UVA Engineering: [Organs on demand? UVA prints its first voxel building blocks](#)
- 2024 — UVA Engineering: [2023 Research Achievement Awards honor UVA Engineering faculty members](#)
- 2023 — UVA Engineering: [UVA-led discovery challenges 30-year-old dogma in associative polymers research](#)
- 2022 — UVA Engineering: [University of Virginia Engineering researchers strive to match artistry of biological tissues](#)
- 2022 — UVA Engineering: [UVA researchers advance bioprinting: New technique uses hydrogel particles to build 3D structures](#)
- 2021 — UVA Engineering: [Research team develops new class of soft materials](#)
- 2020 — UVA Engineering: [UVA researcher imagines super rubber, and has a strategy to make it](#)
- 2020 — UVA Engineering: [CAREER Award: Running hot and cold](#)
- 2017 — Harvard SEAS: [Harvard researchers develop tough, self-healing rubber](#)
- 2015 — Harvard SEAS: [Eliminating entanglements: A new strategy towards ultra-soft yet dry rubber](#)
- 2012 — UNC Chapel Hill: [ENDEAVORS – For cilia's sake](#)

Outreach

- Developed *Science of Cooking* demonstrations for UVA School of Engineering and Applied Science open-house and public-engagement activities; course featured in the *Washington Post* (2021).
- UVA Research Communications Fellow (2022).

❖ APPENDIX: PRESENTATIONS BY TRAINEES

34 oral and 24 poster presentations; work presented at more than one meeting is listed once with all venues. Underline, Cai lab trainee; + undergraduate researcher.

Oral presentations (34)

2026

1. Strain-stiffening in photo-clickable bottlebrush hydrogels via crosslink clustering. Baiqiang Huang, **Li-Heng Cai**. APS Global Physics Summit 2026, Denver, CO.
2. Additive manufacturing of molecular architecture encoded stretchable polyethylene glycol hydrogels and elastomers. Baiqiang Huang, Myoeum Kim, Pu Zhang, Emmanuel Oduro, Daniel Rau, **Li-Heng Cai**. ACS Spring 2026, Atlanta, GA.
3. Multi-material additive manufacturing of polymeric composite structures with seamless soft-hard interface integration from molecular bonding. Emmanuel Oduro, Shahryar Ramezani Bajgiran, Daniel A. Rau, Baiqiang Huang, Alexander Church+, **Li-Heng Cai**. APS Global Physics Summit 2026. Denver, CO, March 15, 2026.
4. Bottlebrush architecture enhanced π - π stacking drives supramolecular hydrogel assembly. Xiaoxiao Ma, Baiqiang Huang, Jinchang Zhu, Ka Un Lao, **Li-Heng Cai**. APS Global Physics Summit 2026. Denver, CO, March 15, 2026.
5. Highly Entangled Bottlebrush Polymer Networks. Myoeum Kim, Baiqiang Huang, Shiwang Cheng, **Li-Heng Cai**. APS Global Physics Summit 2026. Denver, CO.
6. Elasticity promotes directional transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson, Zhijian He, and **Li-Heng Cai**. APS Global Physics Summit 2026. Denver, CO; Mucus, Cilia, and Mucociliary Interactions Gordon Research Seminar, Pomona, CA. February 16, 2025.

2025

7. Fabrication of Bottlebrush Granular Hydrogel using Parallelized Microfluidics. Sara Olsen, Hepi Hari Susapto, Pu (Bruce) Zhang, Baiqiang Huang, Xiaoxiao Ma, and **Li-Heng Cai**. UVA Biomaterials Research Symposium 2025. Charlottesville, VA, July 1, 2025.
8. Decoupling stiffness-extensibility trade-off in unentangled single-network elastomers using foldable bottlebrush polymers as network strands. Baiqiang Huang, Shifeng Nian, and **Li-Heng Cai**. APS Global Physics Summit 2025. Anaheim, CA, March 17, 2025.
9. Hybrid 3D Printing of Anisotropic Bottlebrush Polymer Nanocomposites. Shahryar Ramezani Bajgiran, Emmanuel Oduro, Baiqiang Huang, Daniel Rau, **Li-Heng Cai**. AIChE Annual Meeting 2025. Boston, MA, November 4, 2025.
10. Supramolecular bottlebrush polyethylene glycol hydrogels. Xiaoxiao Ma, Baiqiang Huang, Jinchang Zhu, Ka Un Lao, **Li-Heng Cai**. ACS Fall 2025, Washington, D.C.
11. Multi-material additive manufacturing of polymeric composites with seamless soft-hard interface integration from molecular bonding. Daniel Rau, Baiqiang Huang, Emmanuel Oduro, **Li-Heng Cai**. APS Global Physics Summit 2025, March 17, 2025; 2025 Annual International Solid Freeform Fabrication Symposium (SFF Symp 2025).
12. In-situ measurements of selective UV photocuring using X-ray photon correlation spectroscopy for vat photopolymerization additive manufacturing. Daniel Rau, Lutz Wiegart, Emmanuel Oduro, Baiqiang Huang, **Li-Heng Cai**. 2025 Annual International Solid Freeform Fabrication Symposium (SFF Symp 2025).

2024

13. 3D printable modular soft elastomers from physically crosslinked homogeneous associative polymers. Myoeum Kim, Shifeng Nian, Daniel A. Rau, Baiqiang Huang, Jinchang Zhu, Guillaume Freychet, Mikhail Zhernenkov, **Li-Heng Cai**. American Physical Society March Meeting 2024, Minneapolis, MN. March 4, 2024.
14. Dynamics of polymers with controlled distribution and density of associative groups. Myoeum Kim, Shalin Patil, Siteng Zhang, Ting Ge, Shiwang Cheng, and **Li-Heng Cai**. International Soft Matter Conference. August 2, 2024.

15. A universal strategy for decoupling stiffness and extensibility of polymer networks. Baiqiang Huang, Shifeng Nian, and **Li-Heng Cai**. APS March Meeting 2024, Minneapolis, MN. March 7, 2024.
16. Viscoelasticity promotes directional transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson, Zhijian He, and **Li-Heng Cai**. Chemical Engineering Research Symposium at University of Virginia, Charlottesville, VA. March 15, 2024.
17. Understanding nonlinear fluid dynamics for all-aqueous printing of a viscoelastic droplet in yield-stress fluids. Xiaoxiao Ma, Jinchang Zhu, **Li-Heng Cai**. APS March Meeting 2024, Minneapolis MN. Mar 4, 2024.
18. Digital Assembly of Spherical Viscoelastic Bio-ink Droplets (DASP): a conceptually new bioprinting technology. Jinchang Zhu, **Li-Heng Cai**. APS March Meeting 2024, Minneapolis, MN. March 4, 2024.
19. 3D printing of soft elastomers for brain injury protection structures. Daniel A. Rau, Myoeum Kim, and **Li-Heng Cai**. UVA Postdoctoral Symposium, May 20th, 2024.
20. Multi-material additive manufacturing of polymeric composites with seamless soft-hard interface integration from molecular bonding. Daniel A. Rau, Baiqiang Huang, Alexander Church, Baoxing Xu, **Li-Heng Cai**. International Soft Matter Conference, Raleigh NC. Aug 2, 2024.
21. Fabrication of high-resolution copper lattices through 3D printed PEG bottlebrush hydrogels for enhanced catalysis. Emmanuel Oduro, Yulu Zhang, Daniel Rau, Baiqiang Huang, Sen Zhang and **Li-Heng Cai**. Young Investigator Workshop at International Soft Matter Conference, Raleigh, NC. July 27, 2024.

2023

22. Dynamics of associative polymers with high density of reversible bonds. Myoeum Kim, Shifeng Nian, Shalin Patil, Siteng Zhang, Quan Chen, Mikhail Zhernenkov, Ting Ge, Shiwang Cheng, and **Li-Heng Cai**. American Physical Society March Meeting. March 7, 2023; 8th Virginia Soft Matter (VSM) Workshop. April 22, 2023.
23. Quantifying the transport of *Pseudomonas aeruginosa* in healthy and diseased native mucus. Riley Dickson, Zhijian He, and **Li-Heng Cai**. Virginia Soft Matter Workshop at Virginia Commonwealth University, Richmond, VA. April 22, 2023.
24. Healthy airway mucus promotes directional transport of *Pseudomonas aeruginosa*. Riley Dickson. Chemical Engineering Summer Student Seminar Series at University of Virginia, Charlottesville, VA. July 6, 2023.
25. Real time quantification of shear induced molecular ordering in direct write printing of bottlebrush polymer networks. Daniel A. Rau, Myoeum Kim, and **Li-Heng Cai**. Solid Freeform Fabrication Symposium, Austin TX. Aug 15, 2023.
26. Additive manufacturing of modular soft stretchable elastomers for adaptive dissipative structures. Daniel A. Rau, Myoeum Kim, and **Li-Heng Cai**. Solid Freeform Fabrication Symposium, Austin TX. Aug 15, 2023; Virginia Soft Matter Workshop, April 22, 2023.

2021

27. Molecule-microstructure-property relation of reversible soft materials self-assembled by bottlebrush-based triblock copolymers. Shifeng Nian, Zihao Gong, Guillaume Freychet, Mikhail Zhernenkov, **Li-Heng Cai**. American Physical Society March Meeting. March 19, 2021.
28. 3D printable ultrasoft solvent-free elastomers. Shifeng Nian, Jinchang Zhu, Haozhe Zhang, Zihao Gong, Guillaume Freychet, Mikhail Zhernenkov, Baoxing Xu, **Li-Heng Cai**. American Physical Society March Meeting. March 16, 2021.

2019

29. Molecular architecture driven self-assembly of block copolymers. Shifeng Nian, Zihao Gong, **Li-Heng Cai**. American Physical Society March Meeting. Boston, MA. March 4, 2019.
30. 3D printable soft elastomers. Zihao Gong, Shifeng Nian, **Li-Heng Cai**. American Physical Society March Meeting. Boston, MA. March 5, 2019.

Poster presentations (24)

2026

1. Additive manufacturing of molecular architecture encoded stretchable polyethylene glycol hydrogels and elastomers. Baiqiang Huang, Myoeum Kim, Pu Zhang, Emmanuel Oduro, Daniel Rau, **Li-Heng Cai**. APS Global Physics Summit 2026, Denver, CO.
2. Associative Polymers with Controlled Sticker Placement: How Reversible Bond Distribution and Density Govern Polymer Dynamics. Myoeum Kim, Shalin Patil, Lutz Wiegart, Shiwang Cheng, and **Li-Heng Cai**. APS Global Physics Summit 2026. Denver, CO.

2025

3. Elasticity promotes directional transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson, Zhijian He, and **Li-Heng Cai**. Mucus, Cilia, and Mucociliary Interactions Gordon Research Conference, Pomona, CA. February 18, 2025.
4. A universal strategy for decoupling stiffness and extensibility of polymer networks. Baiqiang Huang, Shifeng Nian, and **Li-Heng Cai**. Poster presentation, Gordon Research Seminar & Gordon Research Conference, South Hadley, MA. June 8 & 12, 2025.
5. Multi-Material Voxel-Bioprinting of Cell-Instructive Biomaterials for Probing Heterotypic Cellular Interactions in 3D Angiogenesis. Jinchang Zhu, **Li-Heng Cai**. 2025 Cold Spring Harbor meeting: Bioengineered Tissue Systems & Models, Huntington, NY. September 29, 2025.

2024

6. Digital Assembly of Spherical Viscoelastic Bio-ink Particles (DASP): a conceptually new bioprinting technology. Jinchang Zhu, **Li-Heng Cai**. Young Investigator Workshop at International Soft Matter Conference, Raleigh, NC. July 27, 2024; International Soft Matter Conference, Raleigh, NC. July 30, 2024; Young Investigator Workshop at Gordon Conference, Manchester, NH. July 21, 2024.
7. Failure in the working curve: Determining interlayer adhesion in stereolithography printing via photorheology. Zoe Benton⁺, Daniel A. Rau, Myoeum Kim, **Li-Heng Cai**. International Soft Matter Conference, Raleigh NC. August 2, 2024.
8. Spatial distribution and density of fibroblasts determine angiogenic response of endothelial cells. Pu Zhang, Melur K. Ramasubramanian, **Li-Heng Cai**. International Soft Matter Conference, Raleigh NC. August 2, 2024.
9. Viscoelasticity of healthy mucus promotes directional transport of *Pseudomonas aeruginosa*. Riley Dickson, Zhijian He, and **Li-Heng Cai**. Young Investigator Workshop at International Soft Matter Conference, Raleigh, NC. July 27, 2024; International Soft Matter Conference, Raleigh, NC. August 2, 2024; Chemical Engineering Research Symposium at University of Virginia, Charlottesville, VA. March 15, 2024.
10. Understanding fluid dynamics for all-aqueous printing of a viscoelastic droplet in yield-stress fluids. Xiaoxiao Ma, Jinchang Zhu, **Li-Heng Cai**. International Soft Matter Conference, Raleigh NC. Aug 2, 2024.
11. Bottlebrush polyethylene glycol nanocarriers translocate across human airway epithelium via molecular architecture enhanced endocytosis. Baiqiang Huang, Zhijian He, and **Li-Heng Cai**. Young Investigator Workshop at International Soft Matter Conference, Raleigh, NC. July 27, 2024; International Soft Matter Conference, Raleigh NC. Aug 2, 2024.
12. Viscoelasticity of healthy mucus promotes directional transport of *Pseudomonas aeruginosa*. Riley Dickson and Zhijian He. University of Virginia Engineering Research Symposium at University of Virginia, Charlottesville, VA. March 28, 2024.
13. Dynamics of polymers with controlled distribution and density of associative groups. Myoeum Kim, Shalin Patil, Siteng Zhang, Ting Ge, Shiwang Cheng, and **Li-Heng Cai**. Young Investigator Workshop at International Soft Matter Conference. Raleigh NC. July 27, 2024.

2023

14. Modeling the stiffness of healthy and diseased lung tissues by a gel-coated air-liquid-interface culture system with tunable substrate stiffness. Zhijian He, Catherine Chu, Riley Dickson, and **Li-Heng Cai**. American Thoracic Society International Conference 2023. Washington DC. May 2023.
15. Transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson, Zhijian He, and **Li-Heng Cai**. Chemical Engineering Research Symposium at University of Virginia, Charlottesville, VA. March 10, 2023.
16. Transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson. American Institute of Chemical Engineers Annual Meeting, Orlando, FL. November 8, 2023.
17. Transport of *Pseudomonas aeruginosa* in native respiratory mucus. Riley Dickson and **Li-Heng Cai**. Virginia Soft Matter Workshop at Virginia Commonwealth University, Richmond, VA. April 22, 2023.
18. Bottlebrush polymers fold in melts. Baiqiang Huang, Shifeng Nian, Guillaume Freychet, Mikhail Zhernenkov, and **Li-Heng Cai**. APS March Meeting 2023, Las Vegas, NV. March 8, 2023.

2022

19. Voxelated Bioprinting: Voxelated Bioprinting of Mechanically Robust Multiscale Porous Scaffolds for Pancreatic Islets. Jinchang Zhu, **Li-Heng Cai**. Fast Movements, Impacts and Deformations: Nature, Robotics and Materials Symposium at Duke University, Durham NC. July 19, 2022.