

UC San Diego

JACOBS SCHOOL OF ENGINEERING  
Aiiiso Yufeng Li Family Department of  
Chemical and Nano Engineering

# Aiiiso Yufeng Li Family Department of Chemical and Nano Engineering

## DEPARTMENT SEMINAR

Wednesday, March 19th, 2025

11:00 AM - 12:00 PM

SME 248

Dr. Liheng Cai, PhD

*"Bottlebrush Polymers, Networks, Biomaterials, and Tissue Mimics"*

Assistant Professor

Materials Science and Engineering, Chemical Engineering,  
Biomedical Engineering, Chemistry, University of Virginia

<https://softbiomatter.org/>



**Abstract:** A bottlebrush polymer consists of a long linear backbone densely grafted with many relatively short side chains. Unlike classical linear polymers, mechanical, biophysical, and biochemical complexities can be independently encoded into the molecular architecture of bottlebrush polymers. This feature enables bottlebrush polymers to emerge as a platform for soft (bio)materials design and innovation. In this talk, I will describe my lab's recent efforts to understand and apply bottlebrush polymers. First, I will introduce a new theoretical framework for the molecular structure of bottlebrush polymers. Corroborated with experiments, we discover that, in some instances, the bottlebrush backbone can fold to store length, a phenomenon opposite to the prevailing understanding of bottlebrush polymers. Second, I will demonstrate that using this so-called foldable bottlebrush polymer as a network strand provides a universal strategy for decoupling stiffness and extensibility of single-network elastomers, the fundamental component of all kinds of polymer networks. Further, I will discuss using bottlebrush polymers as a platform to engineer modular biomaterials for therapeutic delivery. Finally, I will share our recent effort in the development of a voxelated bioprinting technology for engineering 3D tissue mimics for basic and translational biomedicine.

**Bio:** Liheng Cai is an Assistant Professor at the University of Virginia (UVA), where he currently holds joint appointments in the Department of Materials Science and the Department of Chemical Engineering, as well as courtesy appointments in the Department of Biomedical Engineering and the Department of Chemistry. Dr. Cai is also appointed as the UVA School of Engineering and Applied Science Copenhaver Fellow (2025–2028). He received his Ph.D. in Materials Science from the University of North Carolina, where he conducted research with Prof. Michael Rubinstein on theoretical polymer physics and with Prof. Richard C. Boucher on experimental biophysics. During his postdoctoral training with Profs. David Weitz and Jeffrey Fredberg at Harvard, he transitioned to experimental research. Since 2018, he has been leading the Soft Biomatter Laboratory at UVA, where his group focuses on understanding and controlling the interactions between soft (bio)materials and living systems, with the mission of addressing critical challenges in sustainability and human health. Dr. Cai has received the Presidential Early Career Award for Scientists and Engineers (PECASE), NSF CAREER Award, NIH Maximizing Investigators' Research Award (MIRA R35), ACS PMSE Early Investigator Award, and UVA Research Excellence Award. Additionally, he has been recognized as a Soft Matter Emerging Investigator and an ACS Polymers Au Rising Star.

**Seminar Host: Zeinab Jahed**