

## **Charles Edward Sing**

### **Chemical and Biomolecular Engineering**

Assistant Professor

University of Illinois at Urbana-Champaign

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#### **Current Position**

**2014-Present**

**Assistant Professor**

**Chemical and Biomolecular Engineering**

University of Illinois, Urbana-Champaign

#### **Professional Positions**

**2012-2014**

**Postdoctoral Fellow, Materials Science and Engineering  
International Institute of Nanotechnology**

Northwestern University

Supervisor: Prof. Monica Olvera de la Cruz

#### **Education**

**2008-2012**

**PhD. Material Science and Engineering**

Program in Polymer Science and Technology

Massachusetts Institute of Technology

*Dissertation: "Blood-Clotting Inspired Polymer Physics"*

Advisor: Prof. Alfredo Alexander-Katz

**2007-2008**

**M.S. Macromolecular Science and Engineering**

Case Western Reserve University

*Thesis: "Photoluminescent Dye and Polymer Blends as  
Tunable Time-Temperature Indicators"*

Advisor: Prof. Christoph Weder

**2004-2008**

**B.S.E. Polymer Science and Engineering**

Case Western Reserve University

#### **Research Areas**

- Computer simulations of polymer dynamics and equilibrium
- Statistical mechanics and dynamics of charged polymer systems
- Polymer physics of biological materials
- Biologically-inspired functional material design

#### **Honors and Awards**

- NSF CAREER Award (2017)
- Forbes 30 under 30 in Science (2015)
- MIT DMSE Best PhD Thesis Award (2013)
- International Institute for Nanotechnology Postdoctoral Fellow (2012)
- MIT DMSE Graduate Student Teaching Award (2012)

- APS DPOLY Padden Award Finalist (2012)
- MRS Graduate Student Award Silver Medalist (2011)
- National Defense Science and Engineering Graduate Fellowship (NDSEG)
- MIT-Dupont Alliance Presidential Fellowship

### **In Preparation/Submitted Publications**

1. Lytle, T.K.; **Sing, C.E.** "Transfer Matrix Theory of Polymer Complex Coacervation." *Submitted*.
2. Chang, L.W.; Lytle, T.K.; Radhakrishna, M.; Madinya, J.J.; Velez, J.; **Sing, C.E.**; Perry, S.L. "Sequence and Entropy-Based Control of Complex Coacervates." *Submitted*.
3. Johnston, B.M.; Johnston, C.W.; Letteri, R.A.; Lytle, T.K.; **Sing, C.E.**; Emrick, T.; Perry, S.L. "The Effect of Comb Architecture on Complex Coacervation." *Submitted*.

### **Peer-Reviewed Publications**

1. Miao, L.; Young, C.D.; **Sing, C.E.** "An Iterative Method for Hydrodynamic Interactions in Brownian Dynamics Simulations of Polymer Dynamics." *J. Chem. Phys.* **2017** *147*, 024904.
2. Radhakrishna, M.; Basu, K.; Liu, Y.; Shamsi, R.; Perry, S.L.; **Sing, C.E.** "Molecular Connectivity and Correlation Effects on Polymer Coacervation." *Macromolecules* **2017** *50*, 3030-3037.
3. Dahlke, K.; **Sing, C.E.** "Facilitated Dissociation of Dimeric Nucleoid-Associated Proteins Follows Universal Curve." *Biophys. J.* **2017** *112*, 543-551.
4. Smith, C.E., Ernenwein, D.; Clay, N.; Shkumatov, A.; Park, J.; Lee, J.; Misra, S.; **Sing, C.E.**; Zimmerman, S.C.; Kong, H. "Orthogonal Control of Shape and Sensitivity of Paramagnetic Nanoparticle Cluster for Low Dose Diagnosis Imaging" *ACS Appl. Mat. Interf.* **2017** *9*, 1219-1225.
5. **Sing, C.E.** "Development of the Modern Theory of Polymeric Complex Coacervation," *Adv. Coll. Interface Sci.* **2017** *239*, 2-16.  
*Invited Review Article for Coacervation Special Issue*
6. Lytle, T.K.; Radhakrishna, M.; **Sing, C.E.** "High Charge Density Coacervate Assembly via Hybrid Monte Carlo-Single Chain in Mean Field Theory." *Macromolecules* **2016** *49*, 9693-9705.
7. Hsiao, K.W.; Schroeder, C.M.; **Sing, C.E.** "Ring Polymer Dynamics are Governed by a Coupling Between Architecture and Hydrodynamic Interactions." *Macromolecules* **2016** *49*, 1961-1971.
8. Radhakrishna, M.; **Sing, C.E.** "Charge Correlations for Precise, Coulombically-Driven Self Assembly." *Macromol. Chem. Phys.* **2016**  
DOI:10.1002/macp.201500278.  
*Invited 'Talents' Review for Young Investigator Special Issue*
9. Perry, S.L.; **Sing, C.E.** "PRISM-based Theory of Complex Coacervation: Excluded Volume versus Chain Correlation," *Macromolecules.* **2015** *48(14)*, 5040-5053.
10. Giuntoli, R.G.; Linzer, N.B.; Banigan, E.J.; **Sing, C.E.**; Olvera de la Cruz, M.; Graham, J.S.; Johnson, R.C. Marko, J.F. "Dissociation of Proteins from DNA

- Facilitated by DNA Segments in Solution,” *Journal of Molecular Biology* **2015** Available Online.
11. Mai, D.J.; Marciel, A.B.; **Sing, C.E.**; Schroeder, C.M. “Topology-Controlled Relaxation Dynamics of Single Branched Polymers,” *ACS Macro Letters*. **2015** *4*, 446-452.
  12. **Sing, C.E.**; Zwanikken, J.W.; Olvera de la Cruz, M. “Theory of Melt Polyelectrolyte Blends and Block Copolymers: Phase Behavior, Surface Tension, and Microphase Periodicity,” *J. Chem. Phys.* **2015** *142*, 034902.
  13. **Sing, C.E.**; Olvera de la Cruz, M.; “Polyelectrolyte Blends and Nontrivial Behavior in Effective Flory-Huggins Parameters,” *ACS Macro Letters*. **2014** *3*, 698-702.
  14. **Sing, C.E.**; Zwanikken, J.W.; Olvera de la Cruz, M.; “Electrostatic Control of Block Copolymer Morphology.” *Nat. Mater.* **2014** DOI: 10.1038/nmat4001.  
Cover Article
  15. **Sing, C.E.**; Olvera de la Cruz, M.; Marko, J.F. “Multiple-binding-site mechanism explains concentration-dependent unbinding rates of DNA-binding proteins.” *Nuc. Acids Res.* **2013** DOI: 10.1093/nar/gkt1327.
  16. **Sing, C.E.**; Zwanikken, J.W.; Olvera de la Cruz, M.; “Correlation-induced phase separation in polyelectrolyte blends.” *ACS Macro Letters*. **2013** *2*, 1042-1046.
  17. **Sing, C.E.**; Zwanikken, J.W.; Olvera de la Cruz, M.; “Interfacial behavior in polyelectrolyte blends: hybrid liquid-state integral equation and self-consistent field theory study.” *Phys. Rev. Lett.* **2013** *111*, 168303.
  18. **Sing, C.E.**; Selvidge J.G.; Alexander-Katz, A.; “Von Willebrand Adhesion to Surfaces at High Shear Rates is Controlled by Long-Lived Bonds.” *Biophys. J.* **2013** *105*, 1475-1481.
  19. **Sing, C.E.**; Zwanikken, J.W.; Olvera de la Cruz, M.; “Effect of Ion-Ion Correlations on Polyelectrolyte Gel Collapse and Reentrant Swelling.” *Macromolecules*. **2013** *46*, 5053-5065.
  20. **Sing, C.E.**; Alexander-Katz, A.; “Designed Molecular Mechanics Using Self-associating Polymer Components” *Soft Matter* **2012** *8*, 11871-11879.
  21. **Sing, C.E.**; Alexander-Katz, A.; “Force Spectroscopy of Self-Associating Homopolymers” *Macromolecules* **2012** *45(16)*, 6704-6718.
  22. **Sing, C.E.**; Alexander-Katz, A.; “Giant non-monotonic stretching response of a self-associating polymer in shear flow” *Phys. Rev. Lett.* **2011** *107*, 198302.
  23. **Sing, C.E.**; Alexander-Katz, A.; “Equilibrium Structure and Dynamics of Self-Associating Single Polymers” *Macromolecules* **2011** *44(17)*, 6962-6971.
  24. **Sing, C.E.**; Alexander-Katz, A.; “Non-monotonic lift forces on stretched polymers near surfaces.” *EPL* **2011** *95*, 48001.
  25. Einert, T.A.; **Sing, C.E.**; Alexander-Katz, A.; Netz, R.R.; “Internal Friction of Homo-polymeric Systems Studied by Diffusion and Non-equilibrium Unfolding of Globules.” *Eur. Phys. J. E.* **2011** *34*, 130.
  26. **Sing, C.E.**; Einert, T.A.; Netz, R.R.; Alexander-Katz, A.; “Probing Structural Transitions in Polymer Globules by Force.” *Phys. Rev. E* **2011** *83(4)*, 040801(R).
  27. **Sing, C.E.**; Alexander-Katz, A.; “Collapsed polymer behavior in combinations of shear and elongational flow fields.” *J. Chem. Phys.* **2011** *135*, 014902.

28. **Sing, C.E.**; Alexander-Katz, A.; "Theory of tethered polymers in shear flow: the strong stretching limit." *Macromolecules* **2011** 44(22), 9020-9028.
29. Moran, S.E.; **Sing, C.E.**; Alexander-Katz, A.; "Self-Assembled Micro-Walkers" *Proc. of the 2<sup>nd</sup> Eur. Conf. on Microfluidics*. **2010**.
30. Van Lehn, R.C.; **Sing, C.E.**; Chen, H.; Alexander-Katz, A.; "Multidimensional targeting: using physical and chemical forces in unison." *Curr. Pharm. Biotechnol.* **2010** 11, 320-332.
31. **Sing, C.E.**; Alexander-Katz, A.; "Globule-stretch transitions of collapsed polymers in elongational flow fields." *Macromolecules* **2010** 43(7), 3532-3541.
32. **Sing, C.E.**; Alexander-Katz, A.; "Elongational flow induces the unfolding of von Willebrand Factor at physiological flow rates." *Biophys. J.* **2010** 98(9), L35- L37.
33. **Sing, C.E.**; Schmid, L.; Schneider, M.; Franke, T.; Alexander-Katz, A.; "Self-assembled colloidal walkers: from single chain motion to controlled surface-induced flows." *Proc. Natl. Acad. Sci. U.S.A.* **2010** 107(2), 535-540.  
*Featured on the MIT Homepage, as well as numerous media outlets*
34. **Sing, C.E.**; Kunzleman, J.; Weder, C.; "Time-temperature indicators for high temperature applications." *J. Mat. Chem.* **2009**, 19(1), 104-110.
35. Crenshaw, B.; Kunzleman, J.; **Sing, C.E.**; Ander, C.; Weder, C.; "Threshold Temperature Sensors with Tunable Properties." *Macromol. Chem. Phys.* **2007**, 208, 572-580.

#### **Book Chapter**

1. **Sing, C.E.**; Alexander-Katz, A.; "Microwalkers" *Artificial Cilia* **2013**, eds. J. den Toonder and P. Onck. Ch. 9.

#### **Patent**

1. **Sing, C.E.**; Steimel, J.P.; Alexander-Katz, A. "Systems and Methods for Detecting Molecular Interactions Using Magnetic Beads" May 28, 2015. US Patent No. 20150157821.

#### **Invited Talks**

1. "Tuning Complex Coacervation Using Sequence-Defined Polyelectrolytes – A Molecular Understanding" ACS Colloids, New York NY, July 2017.
2. "Monomer Sequence to Self-Assembly in Charged Polymers" Midwest Thermodynamics and Statistical Mechanics Conference, Notre Dame, South Bend IN, June 2017.
3. "Spanning Length Scales in Polymeric Complex Coacervate Self-Assembly" ACS National Meeting, San Francisco CA, April 2017.
4. "Monomer Sequence to Self-Assembly in Charged Polymers" University of Southern Mississippi, Hattiesburg MS, Mar. 28 2017.
5. "Molecular and Sequence Effects in Charged Materials" ACS National Meeting, Philadelphia PA, Aug. 2016.
6. "Exposing New Opportunities in Coacervate Control" ACS National Meeting, Boston MA, Aug. 17 2015.
7. "Blood Clotting and Coarse-Grained Biophysics" MBTG Colin A. Wraight Memorial Symposium, UIUC, Nov. 14 2014.

8. “Polymeric Materials with Highly Correlated Charges” Soft Materials Seminar, Department of Materials Science and Engineering, UIUC, Sept. 2 2014.
9. “Polyelectrolyte Melt Interfaces: Charge Correlation Effects” Polymer Physics Gordon Research Seminar, July 13 2014.
10. “Highly-correlated Charges in Polymer Gels and Blends” Telluride Polymer Physics Workshop, June 17 2013.
11. “Polymer Theory as a Tool for Biological Understanding and Materials Design” University of North Carolina – Chapel Hill, Feb. 19 2013.
12. “Biologically-Inspired Polymer Physics: Theory as a Tool for Understanding and Design” University of Illinois Urbana-Champaign, Jan. 24 2013.
13. “Blood Clotting-Inspired Polymer Physics” University of Washington, Aug. 8 2012. *Distinguished Young Scholar Summer Seminar Series*
14. “Blood Clotting-Inspired Polymer Physics” Case Western Reserve University, Feb. 24 2012.

### **Teaching**

#### **Students and Postdocs Mentored as PI**

Mithun Radhakrishna (Postdoc, 2014-2016, now Asst. Prof. at IIT Gandhinagar)

Katelyn Dahlke (ChBE PhD Student, 2014-Present)

Tyler Lytle (Chemistry PhD Student, 2014-Present)

Linling Miao (ChBE PhD Student, 2015-2017)

Charles Young (ChBE PhD Student, 2016-Present)

Jason Madinya (ChBE PhD Student, 2016-Present, Co-advised w/ Deborah Leckband)

Michael Marvin (M.S. Materials Science, 2014-2016, now at Hyland Software)

Christina Mardyla (ChBE Undergraduate Student, 2015-2016)

June Qian (ChBE Undergraduate Student, 2016-Present)

Anthony Salazar (ChBE Undergraduate Student, 2017-Present)

Jing Zhou (ChBE Undergraduate Student, 2017-Present)

### **Service**

**Journal reviewer:** ACS Macro Letters; Advances in Colloid and Interfacial Science; Biophysical Journal; Chemical Communications; Chemical Science; Colloids and Surfaces A: Physicochemical and Engineering Aspects; Journal of Chemical Physics; Journal of the Royal Society Interface; Journal of Polymer Science Part B: Polymer Physics; Macromolecules; Physical Review E; Physical Review Letters; Proceedings of the National Academy of Science of the USA; Soft Matter

**Proposal reviewer:** National Science Foundation (CBET, DMR) and Stanford Synchrotron Radiation Lab

**Session chair/co-chair:** American Institute for Chemical Engineers Annual Meeting (2014-2017), American Physical Society (2015,2017)