

# Matthew E. Helgeson

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## RESEARCH INTERESTS

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- Thermodynamics, structure, and self-assembly of complex fluids: surfactants, polymers, colloids, and mixed phases
- Non-Newtonian rheology, instabilities, and flow-induced microstructure in complex fluids and complex flows
- Microfluidic and electrohydrodynamic processes for design and synthesis of functional colloids, biomaterials, and nanomaterials

## EDUCATION

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### University of Delaware, Newark, DE (2004-2009)

Ph.D. Chemical Engineering  
Advisors: Prof. Norman J. Wagner, Prof. Eric W. Kaler  
Cumulative GPA: 3.91/4.00

### Carnegie Mellon University, Pittsburgh, PA (2000-2004)

B.S. Chemical Engineering, University and College Honors  
Minors in Colloids, Polymers, and Surfaces; Jazz Performance  
Cumulative GPA: 3.82/4.00

## SELECTED HONORS AND AWARDS\*

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RAP Postdoctoral Fellowship, National Research Council (2009, declined)  
Center for Composite Materials Roy L. McCullough Scholars Award, University of Delaware (2009)  
Neutron Scattering Society of America Prize for Outstanding Student Research (2008)  
University Graduate Fellows Award, University of Delaware (2007)  
Excellence in Graduate Polymer Research Award, ACS POLY Division (2007)  
Robert L. Pigford Fellowship, University of Delaware (2004)  
Carnegie Mellon McCabe Society, Carnegie Mellon University (2004)  
Tau Beta Pi, Pennsylvania Gamma Chapter (2003)

## RESEARCH AND PROFESSIONAL EXPERIENCE

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### Postdoctoral Associate, Department of Chemical Engineering, Massachusetts Institute of Technology (2009-Present)

Supervisor: Prof. Patrick S. Doyle

- Stop flow lithography and microfluidic processing of novel functional and stimuli-responsive colloids
- Synthesis of nano-, meso-, and micro-porous polymer-colloids for heterogeneous crystallization of biomolecules
- Development of microfluidic devices and processes toward continuous manufacturing of pharmaceuticals

### Graduate Student, Department of Chemical Engineering, University of Delaware

Advisors: Prof. Norman J. Wagner, Prof. Eric W. Kaler (Ph.D. Thesis) (2004-2009)

Ph.D. Thesis, Title: "Structure, rheology, and thermodynamics of wormlike micelle-nanoparticle mixtures"

- Integration of rheology, scattering, and optical measurements to investigate microstructure and dynamics in self-assembled systems
- Development and modeling of rheological double networks driven by surfactant-nanoparticle self-assembly
- Constitutive modeling and investigation of shear banding and shear-induced phase transitions in surfactants and polymers
- Measurement and modeling of colloidal interactions in the presence of wormlike micelles and "living" polymers

Supervisors: Prof. Norman J. Wagner, Prof. Dimitris Vlassopoulos (Research Collaboration) (2005-2006)

- Rheological characterization of colloidal star polymer glasses and modeling using mode coupling theory
- Development of rheological phase maps using large-amplitude oscillatory shear flow

Supervisors: Prof. Norman J. Wagner, Dr. Joseph M. Deitzel (Research collaboration) (2004-2005)

- Synthesis of polymer and composite nanofibers, stimuli-responsive colloids using electrospinning and electrospraying
- Development of in-situ flow-kinematic and extensional rheology measurements of polymer jets
- Theory and modeling of electrospinning processes for prediction of jet flow and resulting material properties

### Undergraduate Researcher, Department of Chemical Engineering, Carnegie Mellon University

"Network Passivity Theory Applied to Chemical Process Networks: the HDA Process", Advisor: Prof. Erik Ydstie (2003-2004)

"Correlating Colloidal Properties in Aggregate Suspensions for Wastewater Treatment", Advisor: Dr. Annette Jacobson (2002-2003)

## SKILLS AND TECHNIQUES

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**Colloidal synthesis:** spherical and anisotropic colloids, polymer and coacervate microgels, polymer and composite nanofibers

**Rheology:** Viscometry, conventional rheometry, rheo-optics (flow-birefringence, SALS, SANS), high speed videography, velocimetry

**Microfluidics:** Device design and manufacture, continuous and stop-flow lithography, optical microscopy, image analysis

**Scattering techniques:** Light scattering (static, dynamic, electrophoresis), neutron scattering and reflectometry (NIST)

**Electron Microscopy:** Sample preparation, SEM/TEM (bright field, dark field, scanning), diffraction, XEDS

\*Full list of awards, publications, presentations, and references available upon request

## TEACHING EXPERIENCE

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### University of Delaware, Department of Chemical Engineering, Newark, DE

Department of Chemical Engineering Teaching Fellow, Heat and Mass Transfer (2009)  
Prepared and taught one third of all lectures, authored original material for homework and exams to supplement text

Teaching Assistant, Heat and Mass Transfer/Chemical Engineering Thermodynamics (2006-2007)  
Held office hours, one-on-one tutoring sessions, and review sessions; aided in editing and preparation of course text

### Carnegie Mellon University, Office of Academic Development, Pittsburgh, PA (2003-2004)

Supplemental Instructor/Peer Tutor, Chemistry/Chemical Engineering  
Prepared and led weekly supplemental instruction sessions for students, held one-on-one appointments

## SELECTED PUBLICATIONS AND PATENTS\*

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1. V. Daga, **M.E. Helgeson**, and N.J. Wagner, "Electrospinning of Neat and Laponite-filled Aqueous Poly(ethylene oxide) solutions", *Journal of Polymer Science Part B-Polymer Physics*, 2006. 44: 1608-1617.
2. **M.E. Helgeson** and N.J. Wagner, "A Correlation for the Diameter of Electrospun Polymer Nanofibers", *AIChE Journal*, 2007. 53(1): 51-55.
3. **M.E. Helgeson**, N.J. Wagner, and D. Vlassopoulos, "Linear Viscoelasticity and Non-linear Transitions in a Star Polymer Glass", *Journal of Rheology*, 2007. 51(2): 297-316.
4. **M.E. Helgeson**, K. N. Grammatikos, J. M. Deitzel, and N.J. Wagner, "Kinematic studies of polymer electrospinning using in situ measurements", *Proceedings of the Society for the Advancement of Materials and Process Engineering*, 2007.
5. **M.E. Helgeson**, K. N. Grammatikos, J. M. Deitzel, and N.J. Wagner, "Theory and Kinematic Measurements of the Mechanics of Stable Electrospun Polymer Jets", *Polymer*, 2008, 49(12): 2924-2936.
6. **M.E. Helgeson** and N.J. Wagner, "Investigating the Structural Mechanisms of Shear Banding Using Spatially-resolved Flow-SANS", *NIST Center for Neutron Research Accomplishments and Opportunities*, 2008, SP 1089: 42-43.
7. M.W. Liberatore, F. Nettesheim, **M.E. Helgeson**, E.W. Kaler, N.J. Wagner, P.A. Vasquez, L.P. Cook, L. Porcar, and Y.T. Hu, "Microstructure and Shear Rheology of Wormlike Micelles in Solution", *Journal of Rheology*, 2009, 53(2): 441-458.
8. **M.E. Helgeson**, P.A. Vasquez, E.W. Kaler, and N.J. Wagner, "Rheology and spatially-resolved structure of cetyltrimethylammonium bromide micelles through the shear banding transition", *Journal of Rheology*, 2009, 53(3): 727-756.
9. N.J. Wagner, E.W. Kaler, F. Nettesheim, **M.E. Helgeson**, M.W. Liberatore, "A Method for Building Structure and Viscoelasticity in Surfactant Solutions by Addition of Nanoparticles", US Patent Application #61/001,276 (Pending).
10. **M.E. Helgeson**, M.D. Reichert, Y.T. Hu, and N.J. Wagner, "Relating shear banding and phase behavior in wormlike micellar solutions", *Soft Matter*, In press, DOI: 10.1039/b900948e.
11. **M.E. Helgeson**, T.K. Hodgdon, E.W. Kaler, and N.J. Wagner, "A systematic study of equilibrium structure, thermodynamics, and rheology of aqueous CTAB/NaNO<sub>3</sub> wormlike micelles", *Journal of Colloid and Interface Science*, In preparation.
12. **M.E. Helgeson**, F. Nettesheim, T.K. Hodgdon, E.W. Kaler, N.J. Wagner, "Formation and rheology of viscoelastic double networks in wormlike micelle-nanoparticle mixtures", *Langmuir*, In preparation.

## INVITED PRESENTATIONS AND SEMINARS

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1. Carnegie Mellon University Center for Complex Fluids Seminar Series, Carnegie Mellon University, Pittsburgh PA, March 2009.  
Title: "Controlling the structure and dynamics of wormlike micelles using colloidal particles (and vice versa)".
2. International Conference on Neutron Scattering (invited speaker), Knoxville TN, May 2009.  
Title: "The mechanism of shear banding in wormlike micelles: rheo-SANS measurements of microstructure and structure-property relationships."

## SELECTED CONFERENCE PRESENTATIONS\*

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1. **M.E. Helgeson**, N.J. Wagner, D. Vlassopoulos, "Non-linear viscoelasticity and shear melting of a soft colloidal glass", APS National Meeting, Baltimore MD, March 2006.
2. **M.E. Helgeson**, N.J. Wagner, D. Vlassopoulos, "Linear viscoelasticity and non-linear transitions in a star polymer glass", Society of Rheology - Annual meeting, Portland ME, October 2006.
3. **M.E. Helgeson**, K.N. Grammatikos, J.M. Deitzel, N.J. Wagner, "Formation and mechanics of electrospun polymer jets", ACS Annual meeting - POLY Excellence in Graduate Polymer Science Symposium, Chicago IL, March 2007.
4. **M.E. Helgeson**, K.N. Grammatikos, J.M. Deitzel, N.J. Wagner, C. Krauthausen, "Kinematic studies of electrospun polymer jets using in-situ measurements", SAMPE Annual Meeting, Baltimore MD, June 2007.
5. **M.E. Helgeson**, M.D. Reichert, N.J. Wagner, E.W. Kaler, "Spatially-resolved microstructure in shear banding wormlike micellar solutions," XV<sup>th</sup> International Congress on Rheology, Monterey CA, August 2008.
6. **M.E. Helgeson**, F. Nettesheim, E.W. Kaler, N.J. Wagner, "Controlling the self-assembly of wormlike micellar networks by addition of colloidal particles", ACS Fall National Meeting, Philadelphia PA, August 2008.
7. **M.E. Helgeson**, F. Nettesheim, E.W. Kaler, N.J. Wagner, "Colloidal Interactions In the Presence of Wormlike Micelles", AIChE National Meeting, Philadelphia PA, November 2008.
8. **M.E. Helgeson**, F. Nettesheim, K. Weiß, E.W. Kaler, N.J. Wagner, "Colloidal interactions mediated by wormlike micelles", 13<sup>th</sup> International Conference on Surface and Colloid Science, New York NY, 2009.

\*Full list of awards, publications, presentations, and references available upon request