

# Samya Sen, Ph.D.

Postdoctoral Scholar  
Department of Materials Science & Engineering  
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## EDUCATION

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**University of Illinois Urbana-Champaign** Urbana, IL, USA  
Doctor of Philosophy in Mechanical Engineering Aug 2017 – Jul 2022

- GPA 4.0/4.0
- Doctoral Thesis: *Meaningful descriptions of thixotropy and extensibility for viscoplastic drop impact on thin films* (DOI)
- Advisor: Prof. Randy H. Ewoldt, Ph.D.

**Indian Institute of Technology Kharagpur** Kharagpur, WB, India  
Bachelor of Technology (Hons.) in Mechanical Engineering Aug 2013 – May 2017

- CGPA 9.4/10.0
- Bachelors Thesis: *Experimental investigation of natural convection around heated plates using Schlieren imaging*
- Advisor: Prof. Manab K. Das, Ph.D.

## AWARDS

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**Non-Academic Research Internships for Graduate Students (NSF-INTERN)** Jan – Apr 2021  
University of Illinois, National Science Foundation and PPG Industries

- Industrial internship sponsored by the NSF-INTERN program. Collaboration between Coatings R&D at PPG and Ewoldt Group for developing efficient diagnostic techniques of thixotropic rheology data for industrial coatings formulations.

**PPG-MRL Graduate Research Assistantship Award** Aug 2018 – Apr 2019  
Materials Research Laboratory at University of Illinois and PPG Industries

- Research Assistantship at the 25% level. Support for graduate students working on coatings sciences with complex fluids.

## RESEARCH EXPERIENCE

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**Postdoctoral Scholar, Stanford University** Sep 2022 – present  
Advisor: Prof. Eric A. Appel  
Department of Materials Science and Engineering Stanford, CA, USA

- *Non-ergodic and Stimuli-Responsive Aging in Polymer-Nanoparticle Hydrogels*: Engineered interfacial polymer-particle interactions to discover a unique noncovalent-to-covalent transition and a consequent non-ergodic aging in cellulose-based polymer-silica nanoparticle hydrogels. This transition is tunable using stimuli such as temperature or pH changes, which opens possibilities to design robust materials that exhibit either temperature-independent metastable dynamic crosslinking or time dependent stiffening based on formulation and storage conditions, with applications such as wildfire suppression, surgical adhesives, and depot-forming injectable drug delivery systems.
- *Modular Hydrogels for Tunable Cargo Diffusion and Release Kinetics*: Currently in the process of designing self-assembled transiently crosslinked polymeric networks with modular tunability of network stiffness and relaxation dynamics. I envisage an application in controlled release of therapeutic and biomedical cargo *in vivo* where the relaxation and aging dynamics of the gel network facilitates tunable pharmacokinetics *via* modulating diffusivity and network porosity/mesh size. Upcoming work involves *in vitro* drug release and detailed rheological and mass transport modeling.

**Graduate Research Assistant, University of Illinois**

Advisor: Prof. Randy H. Ewoldt

Department of Mechanical Science and Engineering

Sep 2017 – Jul 2022

Urbana, IL, USA

- *Droplet Impact of Yield-stress Fluids*: Streamlined the understanding of droplet impact behavior of yield-stress fluids on coated substrates. Conducted first-ever experiments studying the effects of material microstructure, thixotropy and elasticity on droplet impact, aimed at improving environmental fire suppression strategies. Published peer-reviewed papers on the effect of microstructure (DOI) and thixotropy (DOI).
- *Spectral Descriptions of Thixotropic Rheology*: Developed material and model independent descriptions for quantifying thixotropic rheology, universally applicable to any complex fluid, using spectral distributions of thixotropic timescales. Improved the fundamental understanding of thixotropic rheology, useful for droplet impact, spray, coating, fire suppression, and 3D printing applications. Published a peer-reviewed paper on the results (DOI).
- *Designing Extensibility into Soft Glassy Materials*: Designed a robust model yield-stress fluid with tunable extensional properties. Demonstrated first experimental evidence of significant decoupling between shear and extensional rheology for the model fluid, with applications in spray, coating, and 3D printing. Developed a novel extensional characterization framework for yield-stress fluids using filament stretching rheometry. Submitted a journal paper currently under review, results available in the arXiv preprint (link).
- *Rheology of Self-amplified Degradable Polymers*: Collaborated with Zimmerman Group (UIUC Chemistry) on understanding dynamics of reagent-triggered self-immolating polymers. Strengthened the discovery of self-immolating degradation mechanisms using rheology. Enabled the mechanical studies of network degradation by marrying concepts from chemical kinetics with rubber elasticity, demonstrating sigmoidal kinetics of network evolution. Published peer-reviewed papers on acid-triggered (DOI) and base-triggered (DOI) degradation. Research Highlight from Nature on the work (link).

**Undergraduate Research Assistant, IIT Kharagpur**

Advisor: Prof. Manab K. Das

Department of Mechanical Engineering

Aug 2016 – Apr 2017

Kharagpur, WB, India

- *Schlieren Imaging in Natural Convection*: Applied laser-based optical technique to study thermal boundary layers in natural convection. Determined temperature fields and heat transfer parameters around heated plates using Schlieren imaging for developing non-invasive flow diagnostics.

**Undergraduate Research Intern, University of Alberta**

Supervisor: Prof. Amit Kumar

Department of Mechanical Engineering

May – Jul 2016

Edmonton, AB, Canada

- *Viscometry of Forest Biomass Slurries*: Devised a novel vane-rotor geometry design for viscometry of high volume-fraction forest biomass slurries. Published a peer-reviewed paper on rheometry methods for biomass-based materials (DOI).

**TEACHING AND MENTORING EXPERIENCE**

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**Graduate Teaching Assistant** | Mechanical Engineering, University of Illinois

Aug – Dec 2018

- *ME270 Design for Manufacturability* with Prof. Bruce Flachsbart: Administered laboratory sessions for 100+ undergraduate students. Mentored students on manufacturing and fabrication techniques, including machining and rapid prototyping. Guided students on independent projects on manufacturing innovative gadgets for daily life problem-solving.
- *TAM435 Intermediate Fluid Mechanics* with Prof. Randy Ewoldt: Evaluated 30+ undergraduate and graduate students on fundamentals of fluid mechanics. Developed homework assignments and solutions, graded students, and gave guest lectures.

**Guest Lecturer** | Mechanical Engineering, University of Illinois

Sep 2019

- *TAM435 Intermediate Fluid Mechanics* with Prof. Randy Ewoldt: Gave guest lectures on the Navier-Stokes equations to 40+ undergraduate and graduate students.

**Laboratory Teaching Assistant** | Mechanical Engineering, University of Illinois Jan – Mar 2020

- *TAM598 Non-Newtonian Fluid Mechanics and Rheology* with Prof. Randy Ewoldt: Administered laboratory lecture sessions for graduate students on the fundamental concepts of rheology, and demonstrated experimental testing techniques on rheometers. Developed laboratory manuals and handouts for streamlined teaching of rheology fundamentals in a laboratory setting aimed at the graduate level.

**Graduate Student Mentor** | Ewoldt Research Group, University of Illinois May 2018 – Dec 2019

- Supervised one undergraduate research assistant through the NSF REU program for the Summer 2018 term, working on droplet impact of yield-stress fluids. Supervised one undergraduate research assistant for the Fall 2019 term, working on thixotropy quantification. Mentored undergraduates on graduate-level projects, helping them gain experimental skills, analytical expertise, and overall research experience preparing them for a career in independent research, academic or industrial.

## PROFESSIONAL EXPERIENCE

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**NSF Graduate Research Intern, PPG Industries** Jan – Apr 2021  
Supervisors: Dr. Chao Wang and Dr. Xinyu Lu Allison Park, PA, USA  
Coatings Innovation Center/Rheology Platform

- *Quantifying Thixotropy of Industrial Coatings Formulations*: Investigated thixotropic and flow rheology of industrial coatings, paints, adhesives, and sealants using rheometry and constitutive modeling. Developed fast, robust experimental protocols for industrial testing of formulations, and devised constitutive models for describing, analyzing, and predicting the flow behavior of industrially relevant thixotropic materials.

## VISUAL PRESENTATIONS

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**Sen, S.**, and R. H. Ewoldt, “Elastic effects in extension with yield-stress fluids,” Gallery of Rheology, Raleigh, NC, USA (2019)

**Sen, S.**, and R. H. Ewoldt, “Stick or Splash? Thixotropy Decides!,” APS DFD Gallery of Fluid Motion, Atlanta, GA, USA (2018)

**Sen, S.**, A. G. Morales, and R. H. Ewoldt, “Thixotropy Visualized with Splashing Droplets,” Gallery of Rheology, Houston, TX, USA (2018)

## REFEREED JOURNAL PUBLICATIONS

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**S. Sen**, R. R. Fernandes, and R. H. Ewoldt, “Soft glassy materials with tunable extensibility,” *Soft Matter* 20, 212–223 (2024). DOI

**S. Sen**, and R. H. Ewoldt, “Thixotropic spectra and Ashby-style charts for thixotropy,” *Journal of Rheology* 66 (5), 1041–1053 (2022). DOI

**S. Sen**, A. G. Morales and R. H. Ewoldt, “Thixotropy in viscoplastic drop impact on thin films,” *Physical Review Fluids* 6, 043301 (2021). DOI

**S. Sen**, A. G. Morales and R. H. Ewoldt, “Viscoplastic drop impact on thin films,” *Journal of Fluid Mechanics* 891, A27 (2020). DOI

Y. Xu, **S. Sen**, Q. Wu, X. Zhong, R. H. Ewoldt, and S. C. Zimmerman, “Base-triggered self-amplifying degradable polyurethanes with the ability to translate local stimulation to continuous long-range degradation,” *Chemical Science* 11, 3326–3331 (2020). DOI

A. Faghani, **S. Sen**, M. Vaezi, and A. Kumar, “Rheology of fibre suspension flows in the pipeline hydro-transport of biomass feedstock,” *Biosystems Engineering* 200, 284–297 (2020). DOI

K. A. Miller, E. G. Morado, S. R. Samanta, B. A. Walker, A. Z. Nelson, **S. Sen**, D. T. Tran, D. J. Whitaker, R. H. Ewoldt, P. V. Braun, and S. C. Zimmerman, “Acid-triggered, acid-generating, and self-amplifying degradable polymers,” *Journal of the American Chemical Society* 141 (7), 2838–2842 (2019). DOI

- S. Sen**, A. C. Yu, C. Dong, A. I. D'Aquino, and E. A. Appel, "Biomimetic non-ergodic aging by dynamic-to-covalent transitions in physical hydrogels," *under review*. arXiv preprint
- C. Dong, A. I. D'Aquino, **S. Sen**, I. A. Hall, and E. A. Appel, "Heat-activated formation of silica aerogels from water-enhancing fire gels," *in preparation*.
- C. Saengow, **S. Sen**, J. Yus, K. M. Chang, A. G. Hoika, E. E. Lovrich, A. A. Pfeil, N. Haug, R. H. Ewoldt, and A. J. Wagoner Johnson, "Highly extensible and self-structured colloidal inks," *in preparation*.
- Y. Wang, **S. Sen**, and R. H. Ewoldt, "Corotational Maxwell is thixotropic in orthogonal superposition rheometry," *in preparation*.
- Y. Wang, **S. Sen**, and R. H. Ewoldt, "Thixotropic build-up and break-down dynamics of the Corotational Maxwell model," *in preparation*.

CONFERENCE PRESENTATIONS

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- C. Saengow, **S. Sen**, J. Yus, K. M. Chang, A. J. Wagoner Johnson, and R. H. Ewoldt, "Imparting extensibility to jammed colloidal inks for direct-ink-writing printability," 8th Pacific Rim Conference on Rheology, Vancouver, BC, Canada (2023)
- S. Sen**, R. R. Fernandes, and R. H. Ewoldt, "Yield-stress fluids with tunable extensibility," Society of Rheology Annual Meeting, Chicago, IL, USA (2022)
- R. H. Ewoldt, and **S. Sen**, "Thixotropy in yield-stress fluid droplet impact," P2SAC Spring 2022 Conference at Purdue University, West Lafayette, IN, USA (2022)
- S. Sen**, and R. H. Ewoldt, "Thixotropic spectra and Ashby-style charts for thixotropy," Society of Rheology Annual Meeting, Bangor, ME, USA (2021)
- S. Sen**, X. Lu, C. Wang, and R. H. Ewoldt, "Quantifying thixotropy using step-rate tests and kinetic structure-based constitutive modeling," Society of Rheology Annual Meeting, Bangor, ME, USA (2021)
- S. Sen**, A. G. Morales, and R. H. Ewoldt, "Microstructure does not matter (sort of): dimensionless groups for viscoplastic drop impact on thin films," International Congress on Rheology, Rio de Janeiro, Brazil (2020)
- S. Sen**, A. G. Morales, and R. H. Ewoldt, "Microstructure does not matter (sort of): dimensionless groups for viscoplastic drop impact on thin films," APS DFD Annual Meeting, Chicago, IL, USA (2020)
- S. N. Kaufman, V. Tipnis, J. Best, L. P. Chamorro, S. Cheng, **S. Sen**, and R. H. Ewoldt, "Quantifying the dynamics of transitional clay flows within nearly isotropic turbulence," APS DFD Annual Meeting, Chicago, IL, USA (2020)
- R. H. Ewoldt, **S. Sen**, and A. G. Morales, "Drop impact of thixotropic yield-stress fluids," APS DFD Annual Meeting, Seattle, WA, USA (2019)
- S. Sen**, and R. H. Ewoldt, "Drop impact of extensible yield-stress fluids," APS DFD Annual Meeting, Seattle, WA, USA (2019)
- S. Sen**, A. G. Morales, and R. H. Ewoldt, "Drop Impact of Thixotropic Yield-stress Fluids," Society of Rheology Annual Meeting, Raleigh, NC, USA (2019)
- S. Sen**, A. G. Morales, and R. H. Ewoldt, "Stick or Splash? Thixotropy Decides," APS DFD Annual Meeting, Atlanta, GA, USA (2018)
- S. Sen** and R. H. Ewoldt, "Towards low-dimensional descriptions of thixotropy," Society of Rheology Annual Meeting, Houston, TX, USA (2018)

## SERVICE AND OUTREACH

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**Student Exhibitor** | The Rheology Zoo, Ewoldt Research Group

Jan 2018 – May 2022

- Demonstrated the “four key phenomena of rheology” to more than 200 visitors during Engineering Open House 2018, 2019, 2022, a campus-wide outreach event at University of Illinois
- Organized and led multiple outreach efforts into spreading knowledge about STEM fields among local primary and high school students

**Student Volunteer** | National Service Scheme, IIT Kharagpur

Aug 2013 - Apr 2015

- Led efforts into weekly after-school tuition for primary schoolchildren in the locality to help support school education
- Organized health camps, blood donation camps, and social awareness rallies among socio-economically under-privileged classes in rural areas around Kharagpur, WB, India

## SKILLS

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**Experimental:** Rheometry, High-speed imaging, Infrared Spectroscopy, Confocal Microscopy

**Computational:** MATLAB, Python

**General Utilities:** Adobe Premiere Pro, Illustrator, Photoshop, MS Office

**Languages:** (native proficiency) English, Hindi, Bengali; (beginner proficiency) Telugu, Latin

## REFERENCES

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Eric A. Appel | *Postdoctoral Mentor*

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Stanford University

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University of Illinois Urbana-Champaign

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