SANTANU KUNDU

Dave C. Swalm School of Chemical Engineering
Mississippi State University, MS 39762
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Education

2001- 2006: Ph.D. in Chemical Engineering, Clemson University, SC, USA
Dissertation Title: *Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch.*

1993-1997: B.E. in Chemical Engineering, Jadavpur University, Kolkata, India

Affiliation

2012 (Jan)-	Assistant Professor, Dave C. Swalm School of Chemical Engineering, Mississippi State, USA
2009-2011	Postdoctoral Guest Researcher, Polymers Division, National Institute of Standards and Technology (NIST), Gaithersburg, USA Virginia Polytechnic Institute and State University, Chemistry Department
2007-2009	Postdoctoral Researcher, Department of Polymer Science and Engineering, University of Massachusetts-Amherst, Amherst, USA
2001-2006	Graduate Research Assistant, Department of Chemical and Biomolecular Engineering, NSF-Clemson-MIT Engineering Research Center for Advanced Engineering Fibers and Films (CAEFF), Clemson University, Clemson, USA
1999-2001	Engineer, Indian Oil Corporation Limited, India
1997-1999	Engineer, TCG Refineries Limited, India

Honors and Awards

Sigma Xi National Scientific Research Honor Society, 2010.
Awarded 1st prize, *Elsevier Carbon Journal award, 2007* for the best Ph.D. dissertation in Carbon Science.
Awarded 2nd prize, *Science as Art exhibit*, Clemson University, 2006.
Finalist, *Prof. H. L. Roy Memorial Award*, Alumni Association, N.C.E. Bengal & Jadavpur University, 1996.
Awarded National Merit Scholarship (India) for higher education, 1991.

Research Interest

My research interest is investigating the *processing-structure-property* relationships for various soft materials towards different applications ranging from bioimplants to energy storage to water purification to structural composites. The emphasis will be identifying and synthesizing suitable materials systems, developing novel synthesis/processing/fabrication strategies for these materials, characterizing these materials using a combination of established and new experimental tools, and studying the engineering aspects needed to facilitate the transition from scientific discovery to practical implementation.

Teaching Interest

My teaching interests are transport phenomena, materials science, polymer science, and soft materials. I believe that teaching is not limited to the classroom and it involves formal and informal discussions with the students outside the classroom.

Research Experience

Postdoctoral Research:

Sustainable Polymers Group, Polymers Division, National Institute of Standards and Technology (NIST), Advisor: Dr. Kathryn L. Beers. (2009-2011)
Virginia Polytechnic Institute and State University, Chemistry Department, Advisor: Prof. Timothy E Long

- Investigated surface, near surface, and viscoelastic properties of thin films, biofilms, elastomers, and hydrogels over multiple length scales.
- Developed a microfluidics/microreactor based platform (Lab-on-a-Chip) to study enzyme catalyzed polymerization and copolymerization of biodegradable polymers.
- Applied Raman spectroscopy to investigate formation of polyhydroxyalkynoates within different strains of bacteria as a function of various growth conditions.

University of Massachusetts-Amherst, Department of Polymer Science and Engineering,
Advisor: Prof. Alfred J. Crosby. (2007-2009)

- Developed cavitation rheology technique to investigate the link between mechanical properties and fracture strength of hydrogels on small length scales, e.g. 1 -1000 μm, at any arbitrary location in the gels.
- Investigated adhesion and mechanical properties of commercially available hydrogels at various environmental conditions. Planned, designed, and developed a custom built setup to measure low adhesion forces (0.1-100 mN).
- Used elastic instabilities such as wrinkling to obtain self forming microstructure at surfaces and studied the effect of these microstructures on the adhesion properties.
- In collaboration with an industrial sponsor, developed a technology to incorporate novel structures on the contact lens surface for performance improvement.

Doctoral Research:

NSF-Clemson-MIT Engineering Research Center for Advanced Engineering Fibers and Films (CAEFF), Clemson University, Advisor: Prof. Amod A. Ogale. (2001-2006)

- Established a unique *flow-3D microstructural* relationship for liquid crystalline carbonaceous oligomers using *polarized optical microscopy* and *X-ray diffraction* in steady shear flow, dynamic flow, and processing flow conditions.
- Performed extrusion and fiber spinning of various polymers and carbon precursors to obtain high performance fibers.
- Determined model parameters from experimental data towards a collaborative CAEFF team effort of developing an advanced constitutive model for liquid crystalline materials.
- Simulated fiber spinning and polymer extrusion process using finite element software (POLYFLOW, FISIM).

Industrial Experience

Engineer, Indian Oil Corporation, India (1999-2001)

- Commissioned a new crude oil distillation unit for petroleum products.
- Designed and implemented various modifications in petroleum distillation unit for enhanced productivity with the assistance of a group of skilled operators.

Engineer, TCG Refineries Limited, India (1997-1999)

- Optimized the configuration of a new petroleum refining unit for improved economy.

Research Expertise

- Rheology and microstructural characterization of structured soft materials
- Characterization of surface and near surface properties of patterned gels, elastomers, and thin films
- Fabrication of patterned surfaces using elastic instabilities, lithography
- Microfluidics/lab-on-a-chip
- Enzymatic catalysis, green chemistry, microbial polymers
- Finite element modeling of polymer processing
- Carbon fibers, High temperature treatment: carbonization and graphitization
- New instrument design. Proficient in LabVIEW
- Quartz Crystal Microbalance (QCM)

Book Chapter

Kundu S and Chan EP, Adhesion *Behavior of Soft Materials* in *Engineering Biomaterials for Regenerative Medicine*, Springer, Sujata K Bhatia(Editor), Springer, 2012. DOI 10.1007/978-1-4614-1080-5_4.

Publications (refereed)

Waters MS, **Kundu S**, Gibson SL. Microstructure and mechanical properties of in situ biofilms, *to be submitted.*

Orski SV, **Kundu S**, Gross RA, Beers KL. Design and Implementation of Two-Dimensional Polymer Adsorption Models: Evaluating the Stability of Candida antarctica Lipase B/Solid-Support Interfaces by QCM-D, in press, *BioMacromolecules, 2013*, DOI: 10.1021/bm301557y.

Kundu S, Johnson PM, Beers KL. Increasing molecular mass in enzymatic lactone polymerizations, *ACS Macro Letters*, 1: 347–351 (2012).

Kratz K, Narasimhan A, Tangirala R, Moon SC, Revanur R, **Kundu S**, Kim HS, Crosby AJ, Russell TP, Emrick T, Kolmakov G, and Balazs AC. Probing and repairing damaged surfaces with nanoparticle-containing microcapsules, *Nature Nanotechnology*, 7, 87-90 (2012). ***(Highlighted in sciencedaily, physorg***)

Hunley MT, Bhangale AS, **Kundu S**, Johnson PM, Gross RA, Beers KL, In situ monitoring of enzyme-catalyzed polymerizations by Raman spectroscopy, *Polymer Chemistry* 3 (2), 314-318(2012).

Johnson PM, **Kundu S**, Beers KL. Modeling Enzymatic Kinetic Pathways for Ring-Opening Lactone Polymerization, *Biomacromolecules*, 12 (9), 3337–3343(2011).

Kundu S, Bhangale AS, William WE, Flynn KM, Guttman CM, Gross RA, Beers KL. Continuous flow enzyme-catalyzed polymerization in a microreactor, *Journal of the American Chemical Society*, 133(15):6006-6011 (2011). ***(Highlighted in NIST newsletter, sciencedaily, physorg***)

Chan EP, **Kundu S**, Lin Q, Beers KL, Stafford CM. Thickness effect on the viscoelastic properties of polystyrene thin films as measured by thermal wrinkling, *ACS Applied Materials & Interfaces*, 3 (2): 331–338 (2011).

Kundu S, Davis CS, Long T, Sharma R**,** Crosby AJ**.** Adhesion of non-planar wrinkled surfaces, *Journal of Polymer Science Part B: Polymer Physics*, 49(3):179-185, 2011 (***Cover Art***).

Kundu S, Ogale AA. Rheostructural studies of a discotic mesophase pitch at processing flow conditions, *Rheologica Acta* 49(8): 845-854 (2010).

Kundu S, Crosby AJ. Cavitation and fracture behavior of polyacrylamide hydrogels, *Soft Matter* 5(20), 3963-3968 (2009).

Kundu S, Grecov D, Rey AD**,** Ogale AA. Shear flow induced microstructure of a synthetic mesophase pitch, *Journal of Rheology* 53(1):85-113(2009).

Kundu S, Naskar AK, Ogale AA, Anderson D, Arnold JR. Observations on a low-angle x-ray diffraction peak for AR-HP mesophase pitch, *Carbon* 46(8):1166-1169 (2008).

Kundu S, Ogale AA. Microstructural effects on the dynamic rheology of a discotic mesophase pitch, *Rheologica Acta* 46(9):1211-1222 (2007).

Kundu S, Ogale AA. Rheostructural studies on a synthetic mesophase pitch during transient shear flow, *Carbon* 44(11): 2224-2235 (2006).

Conference Proceedings

Orski SV, **Kundu S**, Gross RA, Beers KL. Stability of Solid-supported Enzyme Catalysts for Ring-opening Polymerization. *Polymer Preprints*, 53(2), 316-317 (2012).

Waters MS, **Kundu S**, Gibson SL. Structure-mechanical characterization of extracellular polymeric substance from biofilms. *Polymer Preprints*, 53(1), 662-663 (2012).

Hunley MT, Bhangale AS, **Kundu S**, Johnson PM, Gross RA, Beers KL. In situ Raman monitoring of ring-opening copolymerizations. *PMSE Preprints* (2012)

Johnson PM, **Kundu S**, Beers KL. Molecular mass and kinetic modeling of poly(ε-caprolactone) from enzyme catalysis. *Polymer Preprints* 52(1) (2011).

Kundu S, Bhangale A, William WE, Flynn KM, Gross RA, Beers KL. Immobilized enzyme catalyzed polymerization reactions in microreactors. *Polymer Preprints* 51(1):745-746 (2010).

Bhangale A, **Kundu S**, Xie W, William WE, Flynn KM, Beers KL, Gross RA. Impact of immobilization supports for polyesters synthesis activity of Candida Antartica Lipase B. *Polymer Preprints* 51(1):760-761 (2010).

Kundu S, Zimberlin J, Crosby AJ. Cavitation rheology and fracture behavior of soft polymeric materials. Proceedings of the 14th International Conference on Deformation, Yield, and Fracture of Polymers. Rolduc Abbey, Kerkrade, Netherlands. April 2009, 91-92.

Kundu S, Anderson DP, Ogale AA. Rheostructural studies of mesophase pitch using WAXD and OM. "Carbon 2007" Proceedings of International Carbon Conference, Japan (2008).

Rey AD, von Oehsen JB, EDuffy EB, **Kundu S**, Cox CL, Ogale AA. Flow-microstructure of mesophase pitch-based discotic liquid crystalline fluids. Proceedings of the Polymer Processing Society- 23rd annual meeting, Salvador, Brazil (2007).

Kundu S, Ogale AA. Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch, "Carbon 2007" Proceedings of International Carbon Conference, USA (2007).

Grecov D, **Kundu S**, Ogale AA, Rey AD. Flow-induced microstructure of a synthetic mesophase pitch, "Carbon 2007" Proceedings of International Carbon Conference, USA (2007).

Ogale AA, Naskar AK, Walker Robert, **Kundu S**, Sweeney D. Carbon fibers from melt-spun PAN and pitch precursors: composition and process-based control of microstructure, Invited Lecture, International Workshop on Carbon Materials for Energy Applications, Proceedings of Indian Carbon Society, New Delhi, India (2004).

Kundu S, Ogale AA. Rheostructural evolution of AR-HP mesophase pitch in shear flow, "Carbon 2004" Proceedings of International Carbon Conference, USA (2004).

Kundu S, Edie DD, Ogale AA. Rheostructural study of pure and modified mesophase pitches, "Carbon 2003" Proceedings of International Carbon Conference, Spain (2003).

Cho T, **Kundu S**, Lee YS, Rao R, Rao AM, Edie DD, Ogale AA. Processing and structure of nanotube-reinforced mesophase pitch, "Carbon 2002" Proceedings of International Carbon Conference, China (2002).

Selected Presentations/Posters

Kundu S, Waters MS, Calizo I, Hight Walker AR, Beers KL. In Situ Characterization of Polyhydroxyalkanoates Using Surface-Enhanced Raman Spectroscopy. AIChE Annual Meeting. Pittsburg, October-November 2012.

Kundu S, Waters MS, Lin-Gibson S. Microstructure and Mechanical Properties of Bacterial Biofilms. AIChE Annual Meeting. Pittsburg, October-November 2012.

Kundu S, Bhangale AS, Johnson PM, William WE, Gross RA, Beers KL. Continuous flow enzyme-catalyzed polymerization in a microreactor: Reactivity and stability of enzymes. 15th Annual Green Chemistry & Engineering Conference, Washington DC, Jun 2011.

Kundu S, Waters MS, Calizo I, Hight Walker AR, Beers KL. Characterization of bacterial polymer formation using vibrational spectroscopy. Poster presentation, 15th Annual Green Chemistry & Engineering Conference, Washington DC, Jun 2011.

Kundu S. Soft Materials Mechanics: Developing Multi-Scale Structure-Property-Performance Relationships**.** *Invited talk*, Department of Mechanical Engineering, Stevens Institute of Technology, April 2011.

Kundu S. Engineering Sustainable Polymers through Biology. Dave C. Swalm School of Chemical Engineering. Mississippi State University, Mississippi State, March 2011.

Kundu S. Mechanics of Soft Materials: Developing Multi-Scale Structure-Property-Performance Relationships. Department of Chemical Engineering, Louisiana Tech University, Ruston, February, 2011.

Kundu S. Mechanics of Soft Materials: Developing Multi-Scale Structure-Property-Performance Relationships. *Invited talk*, Cabot Corporation Limited, Billerica, February, 2011.

Kundu S, Bhangale A, William WE, Gross RA, Beers KL. Lab-On-a-Chip: a Novel Platform for Enzyme Catalyzed Polymerization Reactions. AIChE Annual Meeting. Salt Lake City, November 2010.

Kundu S, Bhangale A, William WE, Flynn KM, Gross RA, Beers KL. Immobilized enzyme catalyzed polymerization reactions in microreactors. American Chemical Society, Spring Meeting, San Francisco, March 2010.

Kundu S, Sharma R, Crosby AJ. Adhesion Behavior of Non-planar Wrinkled Surfaces. AIChE Annual Meeting. Nashville, November 2009.

Kundu S, Crosby AJ. Cavitation rheology and fracture behavior of polyacrylamide hydrogels, AIChE Annual Meeting. Nashville, November 2009.

Kundu S, Crosby AJ. Cavitation rheology and fracture behavior of polyacrylamide hydrogels, American Physical Society -March meeting, Pittsburgh, USA, March, 2009.

Kundu S, Sharma R, Crosby AJ. Adhesion Behavior of Non-planar Wrinkled Surfaces. Poster presentation, American Physical Society -March meeting, Pittsburgh, USA, March, 2009.

Kundu S. Soft Materials Mechanics: Developing Multi-Scale Structure – Property Relationships. *Invited talk*, American Chemical Society, Delaware Section, December meeting. Newark, December 2008.

Kundu S, Crosby AJ. Cavitation rheology and fracture behavior of polyacrylamide hydrogels. AIChE Annual Meeting. Philadelphia, November 2008.

Kundu S, Zimberlin JA, Crosby AJ. Cavitation rheology and fracture mechanics of polyacrylamide hydrogels. Poster presentation, American Physical Society -March meeting, New Orleans, USA, March, 2008.

Kundu S, Ogale AA. Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch. *Elsevier Carbon Journal award* presentation, International Carbon Conference "Carbon 2007", Seattle, July, 2007.

Kundu S. Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch. *Invited talk*, Department of Polymer Science and Engineering, University of Massachusetts-Amherst, January, 2007.

Kundu S. Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch. *Invited talk*, Prof. Gareth Mckinley's group, Hatsopoulos Microfluidics Laboratory, Department of Mechanical Engineering, Massachusetts Institute of Technology, January, 2007

Kundu S. Investigation of flow and microstructure in rheometric and processing flow conditions for liquid crystalline pitch. *Invited talk*, The Institute for Advanced Learning and Research, The Advanced and Applied Polymer Processing Institute, Virginia, December, 2006.

Kundu S, Ogale AA. Rheostructural Studies of Discotic Liquid Crystalline Materials. Poster presentation, NSF-CAEFF site visit, October, 2006.

Kundu S, Ogale AA**.** Rheo-structural study of a discotic thermotropic mesophase pitch. AIChE Annual Meeting. Cincinnati, November 2005.

Kundu S, Kone A, Ogale AA. Rheostructural Studies of Discotic Liquid Crystalline Materials. Poster presentation, NSF-CAEFF site visit, October, 2005.

Kundu S, Ogale AA**.** Rheology and microstructure of mesophase pitch. *3rd Prize,* Student Presentation Competition, CAEFF Student Retreat, Asheville, August, 2005.

Kundu S, Sweeney D, Naskar A, Ogale AA. Carbon fibers from pitch precursors: rheo-structural characterization of mesophase pitch. Carbons for a Greener Planet Research Frontiers Workshop, Pennsylvania State University, May 2005.

Kundu S, Ogale AA. Rheostructural evolution of AR-HP mesophase pitch in shear flow. Invited presentation in *Jack White Honorary Session,* International Carbon Conference "Carbon 2004", Providence, July, 2004.

Kundu S, Cho T, Edie DD, Ogale AA, Rao R, Parker A, Rao AM. Rheology and microstructure of modified mesophase pitch. Poster presentation, NSF-CAEFF site visit, October, 2003.

Media Coverage

News articles on *Probing and repairing damaged surfaces with nanoparticle, **Sciencedaily, Physorg,** and many others, January 2012.*

News articles on *Enzyme catalyzed polymerization in microreactors*, **Techbeat (*NIST newsletter),* *Sciencedaily, Physorg,** and many others,* March 2011.

Cover art**,** *Journal of Polymer Science Part B: Polymer Physics*, February, 2011

Professional Affiliations

Member, American Chemical Society
Member, American Institute of Chemical Engineers
Member, American Carbon Society

Teaching and Supervisory Experience

Course Instructor
CHE 8523: Advanced Transport Phenomena [Spring, 2012; Spring, 2013]
CHE 3413: Engineering Materials [Fall, 2012]

Graduate Research Advisor
Shamim Osman (MS)
Seyed Meysam Hashemnejad (PhD)

Undergraduate Research Advisor
Arthur Kleiderer (MSU), Spring 2012 – Present
Jeremy Walker (MSU), Spring 2012
Thomas Long (UMass-Amherst), Fall 2007 – Fall 2008
Vukasin Denic (UMass-Amherst), REU student, Summer 2008
Olga Morozova (UMass-Amherst), Summer 2008
Aminata Kone (Clemson University), 2004 – 2006

Graduate Student Mentor
Atul Bhangale (NIST), March 2009 – April 2010

Dissertation/Thesis Committee Member
Maryam Dadgarmoghaddam, Ph.D. Student, Chemical Engineering
Xianchun Zhu, Ph.D. Student, Chemical Engineering
Marta Amirsadeghi, Ph.D. Student, Chemical Engineering

Professional Service

Manuscript, Conference Proceedings, and Book Reviewer
Journal of the American Chemical Society (JACS)
Soft Matter
Advanced Energy Materials
Macromolecular Chemistry & Physics
Polymer Engineering & Science
Journal of Applied Polymer Science
Process Biochemistry
Journal of Chemical Physics
Journal of Colloid and Interface Science
Acta Biomaterialia
Journal of Rheology
ANTEC conference
Textbook: Analysis of Transport Phenomena, William M. Deen (MIT), 2nd Edition, Oxford University Press

Proposal Reviewer
Panelist, Chemical Engineering, National Science Foundation (NSF) Graduate Research Fellowship Program (GRFP), January 9-11, 2013

External WERB manuscript reviewer for NIST
Number of articles reviewed: 3

University, College, and Departmental Committees
Chemical Engineering Graduate Affairs Committee, 2012 –Present

University Working Groups
Materials, 2012-present

Other Service
Oral Presentation Judge, 10th Annual Graduate Student Association Research Symposium, Mississippi State University, 14th April, 2012

Professional Development

Workshops
2012 ASEE Chemical Engineering Summer School, July 20th – 26th, Orono, Maine, 2012.
2nd Annual Neutron Scattering For Novices Workshop, Oak Ridge National Laboratory, Tennessee, May 16th, 2012.
Faculty Development Workshop, Mississippi State University, April 1st, 2012.
Career Planning for Prospective Faculty, AIChE Annual Meeting, Salt Lake City, November 7th, 2010.

Funded Proposals

Title: Mechanical Properties of Pulmonary Mucus
Sponsor: NSF Mississippi Experimental Program to Stimulate Competitive Research (EPSCoR)
Investigator(s): Santanu Kundu (PI)
Period of Performance: 09/01/12-08/31/13
Amount: $36,000