

Alexander C. Barbati

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Massachusetts Institute of Technology
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RESEARCH INTERESTS Complex fluids, nano- and microfluidics, rheology, interface science, electrokinetics, interfacial fluid mechanics, electrochemistry, spectroscopy at interfaces

ACADEMIC RESEARCH EXPERIENCE **Massachusetts Institute of Technology**, Cambridge, MA

Postdoctoral Associate, Gareth McKinley's Non-Newtonian Fluid Dynamics Research Group

- *Microfluidic Devices to Mimic Transport during Hydraulic Fracturing (with Schlumberger)*
Developed a microscale experimental setup to visually probe steady and dynamic transport characteristics of solids carried by a viscoelastic fluid in tortuous and confined geometries. Specific accomplishments include:
 - * Realized a large-scale industrial process in a low-cost device.
 - * Identified important operational parameters in the fracturing process.
 - * Classify regimes of fluid and particle behavior relevant to the fracturing process.
- *Rheology of Particle-laden Fracturing Fluids (with Schlumberger)*
Probed effects of chemical additives, particle concentration, and temperature effects on the linear and non-linear viscoelastic properties of polysaccharide and exotic fracturing fluids. Specific accomplishments include:
 - * Construction of scaling relations and empirical rules to predict effects of particle concentration.
 - * Development of testing procedures to identify causes of material performance issues.

Cornell University, Ithaca, NY

Graduate Student Researcher, Kirby Research Group

- *Electrokinetic Interrogation of Porous and Charged Interfaces*
Devised framework for experimental analysis of porous and charged Nafion polymer films. Developed analytical descriptions of transport through polymer interfaces, and performed numerical modeling to inform material performance within microdevices. Specific accomplishments include:
 - * Developed a parallel-plate electrokinetic cell for materials analysis.
 - * Developed simplified asymptotic expressions to quantify effects of system variables on transport properties.
 - * Developed numerical simulations to model and validate system performance.
- *Microfluidic Control of Neural Growth and Development (with Oregon Health and Science University)*
Designed, fabricated, and implemented microfluidic cell culture platform for the seeding, segregation, and growth of rat hippocampal neurons. Accomplishments include:
 - * Design and fabrication of a biocompatible glass/polymer device.
 - * Modeling to predict distribution of soluble factors in device.

EDUCATION

Cornell University, Ithaca, NY

Ph.D., Mechanical Engineering, January 2014 (GPA: 3.946)

M.S., Mechanical Engineering, January 2011

Thesis Topic: *Small-scale fluid mechanics applied to problems in neurobiology and interface science*

Advisors: Brian J. Kirby, Héctor D. Abruña (minor advisor), Donald L. Koch (minor advisor)







University of Massachusetts at Amherst, Amherst, MA

B.S., *summa cum laude*, Mechanical Engineering and Mathematics (minor), June 2007

Thesis Topic: Sensor placement for detection of roller bearing defects - effective independence expansion method

Thesis Advisor: Robert X. Gao

REFEREED
JOURNAL
PUBLICATIONS

1. Ma, L., J. Wang, J., Marconnet, A., **Barbati, A. C.** McKinley, G. H., Liu, W., Chen, G. "Viscosity and Thermal Conductivity of Stable Graphite Suspensions Near Percolation", *Nano Letters*, (2015) 15:127-133  doi
2. **Barbati, A. C.**, Kirby, B. J. "Electrokinetic Measurements of Thin Nafion Films", *Langmuir*, (2014) 30(8):1985-1993  doi
3. **Barbati, A. C.**, Kirby, B. J. "Force and Flux Relations for Flows of Ionic Solutions between Parallel Plates with Porous and Charged Layers", *Physical Review E*, (2013) 88:042408.  doi
4. **Barbati, A. C.**, Fang, C., Banker, G. A., Kirby, B. J. "Culture of primary rat hippocampal neurons: design, analysis, and optimization of a microfluidic device for cell seeding, coherent growth, and solute delivery." *Biomedical Microdevices*, (2013) 15:97-108.  doi
5. **Barbati, A. C.**, Kirby, B. J. "Soft diffuse interfaces in electrokinetics theory and experiment for transport in charged diffuse layers." *Soft Matter*, (2012) 8:10598-10613.  doi
6. Smith, J. P., **Barbati, A. C.**, Santana, S. M., Gleghorn, J. P., Kirby, B. J. "Microfluidic transport in microdevices for rare cell capture." *Electrophoresis*, (2012) 33:3133-3142.  doi

SUBMITTED
JOURNAL
PUBLICATIONS

1. **Barbati, A. C.**, Desroches, J., Robisson, A., McKinley, G. H. "Complex Fluids and Hydraulic Fracturing" 2015. Submitted to *Annual Review of Chemical and Biomolecular Engineering*. (invited)
2. **Barbati, A. C.**, Kirby, B. J. "Surface conductivity in electrokinetic systems with porous and charged interfaces: Analytical approximations and numerical results.", (2015)

PAPERS IN
PREPARATION

1. **Barbati, A. C.**, Robisson, A., McKinley, G. H. "Elasticity-driven particle transport and accumulation in a microfluidic mimic of a hydraulic fracture", 2015
2. **Barbati, A. C.**, Robisson, A., McKinley, G. H. "Linear and non-linear rheology of particle-laden guar", 2015

AWARDS

Fellowships and Scholarships

- NSF Graduate Research Fellowship 2009-2012
- Alfred Drewes Scholarship 2006

Conference Awards

- Best Poster Award, Physics & Chemistry of Microfluidics GRC 2015

Travel Awards

- MicroTAS 2010, Groningen, The Netherlands Oct 2010
- Gordon Research Conference on the June/July 2009
Physics and Chemistry of Microfluidics, Lucca, Italy

CONFERENCE
PROCEEDINGS AND
PRESENTATIONS

1. **Barbati, A. C.**, Robisson, A., Dussan V., E. B., McKinley, G. H. “Transport of particle-laden viscoelastic suspensions: tuning particle behavior with elasticity and geometry”, APS DFD 2015, Boston, MA.
2. **Barbati, A. C.**, Robisson, A., McKinley, G. H. “Massive elasticity-driven particle accumulation of confined suspensions in kinked and tortuous geometries” 87th Annual Meeting of the Society of Rheology, 2015. Baltimore, MD.
3. **Barbati, A. C.**, Robisson, A., McKinley, G. H. Gordon Research Conference on Microfluidics, Mt. Snow, VT, 31 May–5 June, 2015.
4. **Barbati, A. C.**, Robisson, A., McKinley, G. H. Gordon Research Seminar on Microfluidics, Mt. Snow, VT, 30–31 May, 2015.
5. **Barbati, A. C.**, McKinley, G. H. “Transport of a viscoelastic particle suspension in tortuous geometries”, APS DFD 2014, San Francisco, CA.
6. **Barbati, A. C.** McKinley, G. H. “Rheology and Particle Transport in Viscoelastic Fluids” MIT Mechanical Engineering Research Exhibition 2014, Cambridge, MA.
7. **Barbati, A. C.**, McKinley, G. H. “Rheological behavior of unfilled and filled, uncrosslinked and ionically crosslinked guar solutions” 86th Annual Meeting of the Society of Rheology, 2014. Philadelphia, PA.
8. **Barbati, A. C.**, McKinley, G. H. “Classical and Confined Rheology of Particle-laden Viscoelastic Systems” 60th New England Complex Fluids Workshop, 2014. Waltham, MA.
9. **Barbati, A. C.**, McKinley, G. H. “Classical and Confined Rheology of Particle-laden Viscoelastic Systems” 17th National Congress on Theoretical and Applied Mechanics, 2014. Lansing, MI
10. **Barbati, A. C.**, Kirby, B. J. “Streaming potential and conductivity measurements reveal electrokinetic properties of porous and charged layers”, APS DFD 2013, Pittsburgh, PA
11. **Barbati, A. C.**, Kirby, B. J. “Electrokinetic characterization of soft and charged interfaces: Nafion polymer films.”, 13th Annual New York Complex Matter Workshop, Syracuse, NY
12. **Barbati, A. C.**, Kirby, B. J. “Electrokinetic characterization of soft and charged interfaces: Nafion polymer films.”, APS DFD 2012, San Diego, CA
13. **Barbati, A. C.**, Kirby, B. J. “Streaming potential investigations of novel materials: Nafion polymer films”, 86th ACS Colloid and Surface Science Symposium 2012, Baltimore, MD

14. **Barbati, A. C.**, Kirby, B. J. “Elucidation of Double Layer Phenomena via Flat Plate Streaming Potential of Novel Surfaces: Nafion Polymer Films”, 12th Annual New York Complex Matter Workshop 2011, Ithaca, NY
15. **Barbati, A. C.**, Kirby, B. J. “Fluid properties in the electrical double layer effects on streaming potential at charged interfaces”, APS DFD 2011, Baltimore, MD.
16. **Barbati, A. C.**, Kirby, B. J. Gordon Research Conference on Microfluidics, Waterville Valley, NH. 26 June-1 July 2011
17. **Barbati, A. C.** Gordon Research Seminar on Microfluidics, Waterville Valley, NH 25–26 June 2011. (Seminar Chair)
18. **Barbati, A. C.**, Fang, C., Banker, G. A., Kirby, B. J. “Directed Growth of rat hippocampal neurons in microfluidic culture without surface patterning or chemical gradients”, MicroTAS 2010, Groningen, The Netherlands.
19. **Barbati, A. C.**, Fang, C., Banker, G. A., Kirby, B. J. “Microfluidic Device and Culture Platform for the Observation and Control of Axonal Growth and Axonal Organelle Transport of Rat Hippocampal Neurons”, MicroTAS 2009, Jeju, Korea.
20. **Barbati, A. C.**, Kirby, B. J. Gordon Research Conference on Microfluidics, Lucca, Italy., 27 June-3 July, 2009.
21. Fang, C., Petrie, S. K., Brown, E., Smoody, B., Cohen, A., Mukherjee, A., Roysam, B., **Barbati, A. C.**, Kirby, B. J., Banker, G. “Axonal Transport in Cortical Culture from a Mouse Model of Huntingtons Disease”, Presented 4 Dec. 2008; Neurodegenerative Diseases: Biology & Therapeutics (Cold Spring Harbor Laboratory)
22. **Barbati, A. C.**, Fang, C., Banker, G. A., Kirby, B. J. “Device Fabrication for the Observation of Axonal Growth and Axonal Organelle Transport of Rat Hippocampal Neurons: Control of Cell Attachment via Surface Patterning”, Presented 27 Oct. 2008; 9th Annual Cornell Nanobiotechnology Symposium, Ithaca, NY.
23. **Barbati, A. C.**, Fang, C., Banker, G. A., Kirby, B. J. “Device Fabrication for the Observation of Axonal Growth and Axonal Organelle Transport of Rat Hippocampal Neurons: Control of Cell Attachment via Surface Patterning, Presented 23 Aug. 2008; 1st Annu. Cornell BME Student Retreat, Ithaca, NY.

MENTORING

At MIT

- Tarun Kamath (Intern, Summer 2015)
- Nate Magee (Intern, Summer 2014)

At Cornell University:

- Stacy Yee, University of Michigan (Cornell REU, Summer 2008)
- Michael Christansen, Cornell University, B.S. Bio. E. (2011)
- Moath Othman, San Jose State (Cornell NNIN REU, Summer 2013)

SERVICE

Mentor, NetPals

December 2014 - June 2015

- Mentor 7th grade students from Cambridge, MA on and about science and engineering through weekly e-mails and face-to-face meetings at MIT.

Peer Review,

October 2013 - present

- Macromolecules, Journal of Rheology

- Member**, MIT MTL Student/Postdoc Advisory Board May 2014 - Present
- Advise and communicate with director of the Microsystems Technology Lab (MTL) on a variety of issues affecting the use of MTL facilities and tools.
- Examiner**, Fluid Mechanics Qualifying Exams January 2014, 2015
- Served as examiner for oral qualifying exams in the Department of Mechanical Engineering at MIT.
- Workshop Leader**, 4-H Career Explorations June 2012
- Developed and led a workshop at Cornell University for 18 high-school students to explore and demonstrate engineering fluid mechanics through experimental demonstrations and a design competition building airfoils.
- Member**, Student Faculty Search Committee Spring Semester 2012
- Interviewed and evaluated candidates for biosystems faculty search
 - Made recommendations to faculty search committee
- Conference Chair**, Gordon Research Seminar June/July 2011
- Organized and chaired the first ‘Physics and Chemistry of Microfluidics’ Gordon Research Seminar. Attended by over 50 students and postdocs.
 - Designed seminar and session themes, selected 11 student presentations from submitted abstracts and invited one faculty keynote speaker.
- Professional Development Director**, SiGMA 2008-2009
- Organized talks by external and internal speakers to provide career guidance and development for students in the Mechanical and Aerospace Engineering department at Cornell.

TEACHING
EXPERIENCE

- Guest Lecturer Spring 2014
Macromolecular Hydrodynamics, MIT
Devised and presented a lecture on suspension mechanics and rheology for graduate students and advanced undergraduates.
- Course Organizer & Instructor Summer 2010
Quantum Mechanics Summer Course, Cornell University
Conceptualized, organized, and led a student and faculty group to teach and discuss fundamental quantum mechanics topics
- Teaching Assistant Summer 2009
MAE 3230 - Introductory Fluid Mechanics, Cornell University
Conducted weekly recitations and graded problem sets for approximately 30 students
- Supplementary Instructor Fall 2005
MIE 310 - Dynamics, University of Massachusetts
Developed mini-lectures and practice problems for small groups of students

ACADEMIC
SOCIETIES

- Society of Rheology
American Physical Society

INDUSTRIAL
EXPERIENCE

- Engineering Intern, MKS Instruments Andover, MA 2004-2006
- Performed testing on valves and mass flow controllers for precision metering of gases at reduced atmospheres for semiconductor processing; designed and constructed components, assemblies, and test beds for devices used in semiconductor processing.