SIAMAK MIRFENDERESKI

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EDUCATION

Ph. D., Mechanical Engineering-Fluid Mechanics, 2017 – 2022
University of Nebraska-Lincoln (UNL),
Dissertation: "*Multiscale hydrodynamics and rheology of dense suspensions undergoing nonlinear electrokinetics towards active rheology control*"
Thesis advisor**:** Prof. Jae Sung Park

M. Sc., Mechanical Engineering-Energy Conversion, 2010 – 2013
Amirkabir University of Technology (Tehran Polytechnique), Iran,
Thesis: "*Numerical and experimental study of laminar forced convection of nanofluid in a helical tube at constant heat flux*"
Thesis advisors**:** Prof. Abbass Abassi, and Prof. Majid Safar Avval

B. Sc., Mechanical Engineering, 2005 – 2010
Isfahan University of Technology, Iran,
Thesis: "*Propagation simulation of acoustic waves in room area"*
Thesis advisor: Prof. Saeed Ziaie Rad

JOURNAL PUBLICATIONS

1. J. Brooks, T. Heiman, S. Lorenzen, I. Mungloo, **S. Mirfendereski**, J. S. Park, R. Yang, "Transepithelial Electrical Impedance Increase Following Porous Substrate Electroporation Enables Label-Free Delivery" *Small* (2024)
2. **S. Mirfendereski**, J. S. Park, "Rheology of dense suspensions of ideally conductive particles in an electric field." *J. Fluid Mech.* **977** (2023) A35
3. **S. Mirfendereski**, J. S. Park, "Multiscale nature of electric-field-induced structural formations in non-colloidal suspensions." *Soft Matter* **18**, (2022) 6916-6926.
4. **S. Mirfendereski**, J. S. Park, "Direct numerical simulation of a pulsatile flow in a stenotic channel using immersed boundary method." *Eng. Rep.* **4(1)** (2022) e12444.
5. J.R. Brooks, I. Mungloo, **S. Mirfendereski**, J.P. Quint, D. Paul, A. Jaberi, J.S. Park, R. Yang, "An equivalent circuit model for localized electroporation on track etched membranes." *Biosens. Bioelectron.,* **199** (2022) 113862
6. **S. Mirfendereski**, J. S. Park, "The zero-shear-rate limiting rheological behaviors of ideally conductive particles suspended in concentrated dispersions under an electric field." *J. Rheol.* **65.1** (2021) 13-26.
7. E.A. Davis*, **S. Mirfendereski***, J. S. Park, "On the comparison of flow physics between minimal and extended flow units in turbulent channels." *Fluids* **6.5** (2021) 192. * Equal contribution

8. **S. Mirfendereski**, J. S. Park, "Dipolophoresis in concentrated suspensions of ideally polarizable spheres." *J. Fluid Mech.* **875** (2019) R3
9. M. Mousavi, **S. Mirfendereski**, J. S. Park, J. Eun, "Experimental and numerical analysis of a sustainable farming compartment with evaporative cooling System." *Processes* **7(11)** (2019) 823
10. **S. Mirfendereski**, A. Abbassi, M. Saffar-Avval, "Experimental and numerical investigation of nanofluid heat transfer in helically coiled tubes at constant wall heat flux," *Adv. Powder Tech.* **26** (2015) 1483-1494.

11. S. M. Hosseini, **S. Mirfendereski**, J. S. Park, Two-dimensional dynamics and microstructure of dense suspensions of ideally polarizable particles in an electric field: the non-trivial effect of confinement", (under review)
12. **S. Mirfendereski**, A. Gupta, "lmperfect Turing patterns: diffusiophoretic assembly of hard spheres via reaction-diffusion instabilities" (under prep.).
13. A. Shi, **S. Mirfendereski**, A. Gupta, D. K. Schwartz, " Boundary Effects on Electrokinetic Transport in Interconnected Porous Media" (under prep.)
14. J. Koa, H. Seoa, **S. Mirfendereski**, J. Leea, J. S. Park, S. Y. Kima, S-Y Lee, "Utilization of a blade-free planetary mixer to manufacture hyper-elastic microparticles within a thixotropic medium", (submitted)
15. **S. Mirfendereski**, J. S. Park, "Active rheology control for concentrated suspensions of conductive particles via electric field." (To be submitted)

HONORS AND AWARDS

- *Outstanding Doctoral Dissertation* Award, College of Engineering, UNL, 2023.
- *Outstanding Graduate Research Assistant Fellowship* award, Department of Mechanical & Materials Engineering, UNL, 2022.
- *College of Engineering Professional Development Fellowship* award, College of Engineering, UNL, 2021.
- *Milton E. Mohr Fellowship* award, College of Engineering, UNL, 2021.
- *Milton E. Mohr Fellowship* award, College of Engineering, UNL, 2020.
- *Hemsworth Graduate Fellowship* award, Department of Mechanical & Materials Engineering, UNL, 2019.
- *Travel grant* for the *Open Science Grid (OSG)* school, University of Wisconsin Madison, 2018.

SKILLS

- **Research Expertise**: Fluid mechanics, micro-hydrodynamics, turbulence, colloidal suspensions, porous media, rheology, electrokinetics, transport phenomena, heat transfer, multiphase flow, bio-flow, and complex fluids.

- **Numerical Modeling & Simulation**: Computational fluid dynamics (CFD), solver development, multiphase flow, Stokesian dynamics (SD) simulation, fluid-solid interaction, Immersed Boundary Method, multiphysics simulation, heat transfer, and simulation of reaction-diffusion processes.
- **High-Performance Computing (HPC) & Version Control**: Proficient in large-scale computing, cluster computing, Slurm, and version control systems (Git, GitHub).
- **Programming Languages**: Fortran, MATLAB, Python, Unix Shell, C++.
- **Computer-Aided Engineering (CAE) Software**: ANSYS (CFX, FLUENT), ABAQUS, COMSOL.
- **Computer-Aided Design (CAD) Software**: SolidWorks, Inventor, AutoCAD, CATIA.
- **Optimization & Machine Learning**: Deep learning, unsupervised learning, supervised learning (classification), gradient-based optimization, genetic algorithms.
- **Experimental Techniques**: Thermo-fluidic experimentation, particle image velocimetry (PIV), microfluidics, capillary flow, and exclusion zone formation by ion-exchange membranes.
- **Leadership & Research Management**: Project leadership, mentorship, interdisciplinary collaboration, and guiding research teams toward innovative solutions.
- **Collaborative Problem-Solving:** Strong analytical and strategic thinking skills to tackle complex research challenges in multidisciplinary environments.
- **Research Planning, Execution, and Communication**: Designing and managing research projects, developing methodologies, analyzing results, and communicating findings through scientific writing and technical presentations.

RESEARCH EXPERIENCE

- **Postdoctoral Research Associate** 2024 - present

  Department of Chemical & Biological Engineering, University of Colorado, Boulder

  - Conducting collaborative research with experimental teams to develop physical and phenomenological models for nanoparticle transport in porous media subjected to an external electric field – developed a numerical/theoretical model for the transport of nanoparticles in a porous spherical nano-cavity.
  - Developed fast, multi-component Eulerian-Lagrangian simulation model of chemotaxis and diffusiophoretic particles under reaction-diffusion signals – creating more realistic representations of biological pattern formation (Turing pattern).
  - Investigating particle assembly and evolutionary behaviors using coupled reaction-diffusion and cellular automata models.
  - Lead research on exclusion zone formation induced by ion-exchange membranes and diffusiophoresis, exploring flow instability (Rayleigh-Taylor) through experiments and multi-physics modeling.

- Mentoring, advising, and coordinating students on research activities.

- **Postdoctoral Research Associate** 2023 - 2024

  Department of Mechanical & Materials Engineering, University of Nebraska-Lincoln

  - Created a high-fidelity particle-level simulation solver using the Stokesian Dynamics method for simulating the pressure-driven flow of dense particle suspensions – predicting microstructure and macroscopic/rheological properties under external fields.
  - Created a CFD solver for direct numerical simulation (DNS) of turbulent channel flow under pulsatile inflow and body force to analyze the effects of pulsation and body force on drag reduction and energy savings.
  - Developed a physical model for flow control and turbulent drag reduction using superhydrophobic surfaces by performing direct numerical simulations.
  - Developed active rheology control system for conductive particle suspensions under external electric fields.
  - Explored rheology & multiscale structures of electrorheological (smart) fluid via Stokesian dynamics simulations
  - Mentored graduate students in computational fluid dynamics (CFD), particle-level modeling, and research activities.

- **Graduate Research Assistant** 2017 – 2022

  Department of Mechanical & Materials Engineering, University of Nebraska-Lincoln

  - Developed an in-house Stokesian dynamics (SD) simulation solver in Fortran for large-scale simulations of particle suspensions driven by external shear flow and nonlinear electrokinetic phenomena in an electric field.
  - Performed 100+ SD simulations to characterize the dynamics & rheology of dense conductive suspensions undergoing both external shear flow and electric field – proposing a novel active rheology control strategy via an external electric field.
  - Performed large-scale numerical simulation using the “Smooth Particle Mesh Ewald” method to characterize the dynamics & rheology of dense suspensions undergoing nonlinear electrokinetic phenomena – studying the effect of Brownian motion.
  - Conducted multi-scale structural analysis of dipolar interactive particle suspension in an applied electric field.
  - Developed a theoretical/numerical model for the electroporation of nanoparticles in nano/micro-channels in collaboration with an experimental group to optimize porous substrate electroporation for efficient drug delivery.
  - Performed direct numerical simulation (DNS) to characterize the minimum flow units in turbulent channel flow**.**

- Developed an in-house DNS solver coupled with Immersed Boundary Method IBM using Fortran to simulate blood flow in stenotic arteries and study the atherosclerosis progression.
- Developed a multi-scale CFD solver using the Force Coupling Method (FCM) in Fortran for studying particle motion in blood flow.
- Created a boundary-fitted CFD code for simulating airflow & heat transfer in sustainable farming compartments.
- Developed a CFD code for fluid flow simulation in inhomogeneous porous media.
- Developed a Volume of Fluid code for simulating flow in extrusion-based bioprinting.
- Performed Stereo Particle Image Velocimetry (SPIV) experiments of turbulent boundary flow in collaboration with Prof. Longmire's lab at the University of Minnesota.
- Mentored new graduate students in their research endeavors.

- **Graduate Researcher** 2010 – 2013

  Department of Mechanical Engineering, Amirkabir University of Technology

  - Developed an in-house CFD solver in Fortran for simulating flow and convection heat transfer of nanofluid inside the helical tubes (as part of my Master's thesis).
  - Designed and constructed helical coil heat exchangers and developed an experimental model alongside the numerical model (as part of my Master's thesis).

EDITORIAL AND SERVICE ACTIVITIES

- Session chair at the American Physics Society-Division of Fluid Dynamics conference, 2024
- Vice-president in Postdoctoral Association of Colorado Boulder, CU Boulder, 2024 - 2025.
- Proceeding reviewer for Journal of Fluid Mechanics, 2024 - 2025.
- Proceeding reviewer for ASABE Journal, 2024.
- Volunteered as a poster presentation judge for Spring Research Fair, UNL, 2023.
- Volunteered as a poster presentation judge for the Graduate Student Symposium, UNL, 2023.
- Proceeding Reviewer for JAFM Journal, 2021.
- Proceeding Reviewer for ASME-IMECE Conference 2020-2023.
- Proceeding Reviewer for ASME-JSME-KSME (AJK) Joint Fluids Engineering Conference, 2019.

TEACHING EXPERIENCE

- Completed the Institute for **International Teaching Assistants**, University of Nebraska-Lincoln, 2019.
- **Lab Instructor**, heat transfer Lab, Amirkabir University of Technology, 2012
  - Taught heat transfer lab - assisted students during office hours, and graded reports, exams, and assignments.

INDUSTRIAL EXPERIENCE

- **Mechanical Engineering Consultant (self-employed contractor)** 2015 – 2017
  - Engineered, designed, & constructed "Ceiling-mounted Telescopic Barriers" under contract with "Sepahan Nikoo Faraz Darb Co".
  - Conducted cost evaluations for the construction of automatic precast concrete plants, while also undertaking preliminary machinery design tasks as part of a potential startup venture.
  - Engineered & designed lent processing machines under contract with "Fanarlool Tehran Industrial Co".
- **R&D engineer at ARAMICO CO** 2012 – 2014
  - Utilized ANSYS-CFX software for numerical modeling of the Hydromatrix turbine unit.
  - Engineered and fully designed the "Skip elevator" unit for the under-construction plant using SolidWorks —earned CEO acclaim for its successful operation upon completion.
- **Mechanical engineer (intern) at ATLAS MACHINE CO** 2009
  - Engineered and designed dust box arrangement for the Ingot machine using Inventor professional software.

AFFILIATIONS & CERTIFICATES

- American Physical Society (**APS**)
- Society of Rheology (**SOR**)
- American Chemical Society (**ACS**)
- The American Society of Mechanical Engineering (**ASME**)
- American Institute of Chemical Engineers (**AIChE**)
- Certificate in **Rheology: Principles, Measurements, and Applications**, Newcastle DE, Aug 17-19, 2021.
- Certificate in **Suspension/Granular Rheology**, *The Society of Rheology*, Raleigh NC, Oct 19-20, 2019.

RESEARCH INTERESTS

- Fluid Dynamics
- Computational Fluid Dynamics
- Stokesian Dynamics Simulations
- Micro-hydrodynamics
- Turbulent Flow
- Porous Media
- Fluid Flow in Complex Geometries
- Complex Fluids
- Rheology
- Bio-fluids
- Machine Learning
- Particle-laden Flow
- Optimization
- Renewable Energies
- Electrokinetics
- Active Matter
- Fluid-Solid Interaction
- DNS
- Micro-Fluidics
- Experimental Studies
- PIV

CONFERENCE PRESENTATIONS

1. **S. Mirfendereski**, E. Colman, A. Gupta, (2024), "Particle-Level simulations using diffusiophoresis and cellular automata to create dynamic Turing patterns", *76th Annual Meeting of the APS-DFD,* Salt Lake City, UT.
2. L. Bayer, **S. Mirfendereski**, A. Gupta, (2024), "Diffusiophoresis-Induced Rayleigh-Taylor Instability", *76th Annual Meeting of the APS-DFD,* Salt Lake City, UT.
3. E. Colman, **S. Mirfendereski**, A. Gupta, (2024), "A Reaction-Diffusion-Chemotaxis Model to Understand the Collective Behavior of Microbial Life", *76th Annual Meeting of the APS-DFD,* Salt Lake City, UT.
4. **S. Mirfendereski**, B. Alessio, E. Colman, A. Gupta, (2024), "Diffusiophoresis-Enhanced Turing Patterns: Continuum and Particle-level Simulations" in the technical session Directed and Self-Assembly" *98th ACS Colloids and Surface Science Symposium,* UW, Seattle, WA
5. **S. Mirfendereski**, B. Alessio, E. Colman, A. Gupta, (2024), "Merging Turing Patterns & Cellular Automata: Simultaneously Assembling & Evolving Structures", *ACS Fall,* Denver, CO
6. **S. Mirfendereski**, A. Gupta (2024) "Merging Turing Patterns and Cellular Automata: Simultaneously Assembling and Evolving Structures Via Diffusiophoresis", *2024 AICHE Annual Meeting,* San Diego, CA
7. **S. Mirfendereski,** J.S. Park, (2024), "Dynamics and rheology of dense suspensions of highly conductive particles in an electric field: towards active rheology control", ICTAM, Daegu, South Korea.
8. **S. Mirfendereski**, J. S. Park, (2023) "Tunable rheology of dense suspensions of conductive particles via an applied electric field.", *75th Annual Meeting of the APS-DFD,* Washington, DC.
9. **S. Mirfendereski**, J. S. Park, (2023) "Toward a physical model for the effective slip length of superhydrophobic surfaces in turbulent flows", *75th Annual Meeting of the APS-DFD,* Washington, DC.
10. S.M. Hosseini, **S. Mirfendereski**, J. S. Park, (2023) "Non-equilibrium gel formation in suspensions of conductive particles in electric field", *75th Annual Meeting of the APS-DFD,* Washington, DC.
11. **S. Mirfendereski**, S.M. Hosseini, J. S. Park, (2023) "Multiscale responses of sheared of non-colloidal particles undergoing dipolar interactions in an electric field", *97th ACS Colloid and Surface Science Symposium*, Raleigh, NC.
12. S.M. Hosseini, **S. Mirfendereski**, J. S. Park, (2023) "Confinement-induced dynamics in two-dimensional suspensions of conductive particles in an electric field", *97th ACS Colloid and Surface Science Symposium*, Raleigh, NC.
13. **Mirfendereski**, J. S. Park, (2022) "Micro-meso-macroscale responses of non-colloidal suspensions undergoing dipolar interactions in an electric field: effects of confinement", *75th Annual Meeting of the APS-DFD,* Indianapolis, IN.
14. SM. Hosseini, J. S. Park, **S. Mirfendereski**, (2022) "Static and dynamic equilibrium states driven by induced-charge electrophoresis in two-dimensional suspensions", *75th Annual Meeting of the APS-DFD,* Indianapolis, IN.
15. **S. Mirfendereski**, J. Brooks, J. S. Park, R. Yang (2022) "Electrokinetics-Driven Transport of Charged Nanoparticles Through Micro and Nanochannels", *IMECE2022-99799*, Columbus, OH.
16. **S. Mirfendereski,** J. S. Park, (2022) "Electric-field-induced active rheology control for concentrated suspensions of conductive particles" *93rd Annual Meeting of The Society of Rheology*, Chicago, IL.
17. **S. Mirfendereski**, J. S., Park, (2022) "Collective dynamics and rheology of concentrated suspensions of conductive particles in an electric field: Implications for active rheology control" *96th ACS Colloid and Surface Science Symposium,* Golden, CO.

18. **S. Mirfendereski**, J. S., Park, (2022) "Nonlinear electrokinetic effects on dynamics and rheology of concentrated suspensions of conductive particles in shear flow" *19th USNCTAMS,* Austin, TX.
19. **S. Mirfendereski**, J. S., Park, (2021) "Multi-scale dynamics of semi-dilute and concentrated suspensions of dielectric particles in an electric field." *74th Annual Meeting of the APS-DFD,* Phoenix, AZ.
20. E. A. Davis, J. S., Park, **S. Mirfendereski** (2021) "On the efficacy of minimal flow units in simulating" healthy" turbulence in plane Poiseuille flows." *74th Annual Meeting of the APS-DFD,* Phoenix, AZ.
21. **S. Mirfendereski**, J. Brooks, R. Yang, J.S. Park (2021) "Electrokinetic transport of nanoparticles through micro and nanochannels" *AICHE Annual Meeting*, Boston, MA.
22. **S. Mirfendereski**, J. S. Park, (2021) "Computational study on flow physics and hemodynamic parameter in single and double stenotic Channels" *IMECE2021-77229*, online.
23. **S. Mirfendereski**, J. S. Park, (2021) "Modeling and validation of extrusion-based biomaterials printing in additive manufacturing" *IMECE2021-77348*, online.
24. **S. Mirfendereski**, J. S. Park, (2021) "Rheology of sheared suspensions of conductive particles in an electric field." *92nd Annual Meeting of The Society of Rheology,* Bangor, ME.
25. **S. Mirfendereski**, J. S. Park (2021) "Effects of Brownian diffusion on dynamics of concentrated suspensions of ideally conductive particles in an electric field" *APS March meeting 2021*, online.
26. **S. Mirfendereski**, J. S. Park (2020) "Dynamics and rheology of conductive particle suspensions in an electric field from dilute to concentrated regimes" *18th International Congress on Rheology*, online.
27. **S. Mirfendereski**, J. S. Park (2020) "Direct numerical simulations of semi-dilute and concentrated suspensions of non-conductive particles in an electric field." *73rd Annual Meeting of the APS-DFD* online.
28. E. Davis, A. Sareen, **S. Mirfendereski**, E. Longmire, J. S. Park (2020) "Characterization of low-drag events at a moderate Reynolds number of $Re_\tau = 700$." *73rd Annual Meeting of the APS-DFD,* online.
29. J. S. Park, **S. Mirfendereski**, (2020) "Direct numerical simulation of pulsatile flow around single or double stenosis using Immersed Boundary Method" *IMECE2020-25077*, online.
30. **S. Mirfendereski,** J. S. Park, (2019) "Non-intuitive behavior in concentrated suspension of ideally polarizable particles in an electric field." *72nd Annual Meeting of the APS-DFD*, Seattle, WA.
31. **S. Mirfendereski**, J. S. Park, (2019) "Dynamics and rheology of concentrated suspensions of polarizable particles in an electric field." *91st Annual Meeting of The Society of Rheology.* Rayleigh, NC.
32. **S. Mirfendereski**, F. Aghabaglou, A. Tamayol, J. S. Park (2019) "Predicting the distribution of drugs delivered using needleless liquid Jet Injectors*." IMECE2019-13103*, Salt Lake City, UT.
33. **S. Mirfendereski**, J. S. Park, (2019), "A particle-level computational investigation of electrophoretic deposition for fabrication of battery electrodes." *AJKFLUIDS2019-5551*, San Francisco, CA.
34. **S. Mirfendereski**, J. S. Park (2019) "Particle-laden slurry flow in an electric field" *UNL research fair*, Lincoln, NE.
35. **S. Mirfendereski**, J. S. Park, (2018) "Electrokinetics in concentrated suspensions of ideally polarizable spheres." *71st Annual Meeting of the APS Division of Fluid Dynamics*, Atlanta, GA.
36. **S. Mirfendereski**, J. S. Park, (2018), "Fluid-structure interactions using an Immersed Boundary Method: A turbulence generator." *IMECE2018-89305*, Pittsburg, PA.

37. J. S. Park, **S. Mirfendereski**, S. Mousavi, J. Eun, (2018) "Dynamic numerical simulation of heat transfer and fluid flow in Sustainable Farming Compartment." *IMECE2018-89254*, Pittsburg, PA.
38. **S. Mirfendereski**, J. S. Park, (2018) "Dynamics of concentrated suspensions of polarizable particles under an electric field" *2nd Annual Nebraska Microfluidic Symposium at Creighton University*, Omaha, NE.
39. **S. Mirfendereski**, J. S. Park, (2018) "Concentrated suspensions in an electric field: Suspension dynamics and rheology*". 90th Annual Meeting of The Society of Rheology*, Houston, TX.
40. **S. Mirfendereski**, J. S. Park, (2017), "Dynamic fluid/heat transport simulations of sustainable farming compartment", *MME third Annual Research fair*, Lincoln, NE.