Current as of August 28, 2019

RANGANATHAN GOPALAKRISHNAN

Assistant Professor, Department of Mechanical Engineering, Herff College of Engineering
320 Engineering Science Building, The University of Memphis, Memphis, TN 38152
Office: +1-901-678-2580; Email: rgplkrsh@memphis.edu
http://www.memphis.edu/me/faculty/gopalakrishnan.php
https://scholar.google.com/citations?user=tQrZ9j4AAAAJ&hl=en&oi=ao

for currently active projects: See page 6

Professional Experience:

- Assistant Professor, Department of Mechanical Engineering, The University of Memphis
  August 2016 – present

- Visiting Academic Fellow/Professor, Laboratoire des Sciences des Procédés et des Matériaux, University Paris XIII, July 1 – 20, 2018.

- Lecturer, Department of Mechanical and Industrial Engineering, The University of Iowa
  August 2015 to July 2016

- Postdoctoral Scholar in Chemical Engineering, University of California at Berkeley.
  October 2014 to July 2015

- Postdoctoral Scholar in Chemical Engineering, California Institute of Technology.
  September 2013 to September 2014.

Education:

- Ph. D., University of Minnesota – Twin Cities, Minneapolis, MN, U. S. A. August 2013.
  Co-Advisers: Prof. Christopher J. Hogan Jr. and Prof. Peter H. McMurry
  Thesis Title: Transition Regime Collisions in Aerosols
  Recipient of 2012-13 University of Minnesota Doctoral Dissertation Fellowship
  Honorable Mention, University of Minnesota Best Dissertation Competition 2014

- Bachelor of Technology (Mechanical Engineering), National Institute of Technology, Tiruchirappalli, India. May 2008.

Courses taught:

At The University of Memphis:

MECH 4309/6309 Gas Dynamics (Fall 2016)
MECH 4990/6990 Aerosol Engineering (Spring 2017)
MECH 7341/8341 Engineering Analysis I (Fall 2017)
MECH 7378/8378 Introduction to Computational Fluid Dynamics (Spring 2018)
MECH 7342/8342 Engineering Analysis II (Spring 2018)

MECH 3331 Fluid Mechanics (Fall 2018)
MECH 3341 Numerical and Statistical Methods (Spring 2019, Fall 2019)
MECH 3311 Thermodynamics I (Fall 2019)

At The University of Iowa:

ME 3351 Engineering Instrumentation (Fall 2015)
ME 4080 Experimental Engineering (Fall 2015, Spring 2016)
ME 4086 Mechanical Engineering Design Project (Spring 2016)
ME 3052 Mechanical Systems (Spring 2016)

At University of Minnesota – Twin Cities:

- Teaching Assistant for ME 4031W: Basic Mechanical Measurements Laboratory
  Course Instructor: Prof. Peter H. McMurry
  Terms: Fall 2009, Fall 2010, Spring 2011, Fall 2011, Spring 2012
- Teaching Assistant for ME 3332: Thermal Sciences II
  Course Instructor: Prof. Christopher J. Hogan Jr.
  Term: Spring 2010

Student Advising:

MS Graduates

- Mr. Ewe Jiun Chng
  - Thesis Title: Mechanical Characterization of Chitosan Coating Deposited Using Electrospray Method
  - Graduation: May 2018
- Mr. Lekhnath Pokharel
  - Thesis Title: Development of Aerosol Deposition Apparatus for Processing Thin Ceramic Films at Room Temperature
  - Graduation: May 2018
- Mr. Harjindar Singh Chahl
  - Thesis Title: Coulombic Collisions in Aerosols and Dusty Plasmas
  - Graduation: May 2019
- Mr. Prashant Parajuli
  - Thesis Title: Dense Coating of Hydroxyapatite Particles Over Titanium Alloy by Aerosol deposition Method
  - Graduation: May 2019

PhD Candidates

- Mr. Rayhan Ahmed (since August 2016)
- Ms. Li Li (since August 2017)
- Mr. Vikram Suresh (since August 2018)

Professional Service:

- Editorial Board Member, Nature Scientific Reports
- Peer Reviewer, Aerosol Science and Technology, Journal of Aerosol Science, Nature Scientific Reports, Journal of Chemical Physics, Bioengineering & Translational Medicine, Atmospheric Measurement Techniques

Department/College/University-level Service:

- Member of the Undergraduate Curriculum Process Team, Department of Mechanical Engineering (Aug 2016 – Nov 2018)
- Member of the Graduate Curriculum Process Team, Department of Mechanical Engineering (Nov 2018 – present)
- Member of the Faculty Search Committee, Department of Mechanical Engineering (Fall 2017 & Spring 2018)

Externally Sponsored Research Grants:

1. National Science Foundation Division of Physics
    - "An effective potential approach to the modeling of concentrated dusty plasmas"
    - Amount: $199,673
    - Duration: July 1, 2019 – June 30, 2022

https://nsf.gov/awardsearch/showAward?AWD_ID=1903432&HistoricalAwards=false

The University of Memphis Internal Research Grants:

1. DRONES Research Award
    - "Spray-coated Perovskite Solar Cells – Phase 1"
    - Amount: $10,000
    - Awarded by: FedEx Institute of Technology, The University of Memphis
    - Duration: February 1, 2017 – June 30, 2018

2. Herff Faculty Research Grant
    - "A Novel Electrostatic Deposition Technique for Manufacturing Next Generation Single Nanoparticle Transistors and Sensors"
    - Amount: $6,000
    - Awarded by: Herff College of Engineering, The University of Memphis
    - Duration: July 1, 2017 – December 31, 2018

3. Green Fee Fund Campus Improvement Grant
    - "Sprayable Solar Cells for Campus Lighting and Safety – Phase 1"
    - Amount: $27,000
    - Awarded by: The University of Memphis Green Fee Allocation Committee
    - Duration: July 1, 2017 – June 30, 2018

4. Green Fee Fund Campus Improvement Grant
    - "Sprayable Solar Cells for Campus Lighting and Safety – Phase 2"
    - Amount: $30,000
    - Awarded by: The University of Memphis Green Fee Allocation Committee
    - Duration: July 1, 2018 – June 30, 2019

5. DRONES Research Award 2018
    - "Spray-coated Perovskite Solar Cells – Phase 2"
    - Amount: $27,500
    - Awarded by: FedEx Institute of Technology, The University of Memphis
    - Duration: July 1, 2018 – December 31, 2019

6. FIT Development Grant
    - "Ultrasonic Dispersion of Cohesive Dry Powders"
    - Amount: $20,000
    - Awarded by The University of Memphis Research Foundation
    - Duration: September 1, 2018 – December 31, 2019

Peer Reviewed Publications: (* - student advisees of Dr. Gopalakrishnan)

1. **Gopalakrishnan, R.,** & Hogan, C. J. (2011), Determination of the transition regime collision kernel from mean first passage times. *Aerosol Science and Technology, 45: 1499-1509.*
2. **Gopalakrishnan, R.**, Thajudeen, T. & Hogan, C. J. (2011), Collision limited reaction rates for arbitrarily shaped particles across the entire diffusive Knudsen number range. *Journal of Chemical Physics, 135: 054302.*
3. **Gopalakrishnan, R.,** & Hogan, C. J. (2012), Coulomb-influenced collisions in aerosols and dusty plasmas. *Phys. Rev. E, 85: 026410.*
4. Thajudeen, T., **Gopalakrishnan, R.** & Hogan, C. J. (2012), The collision rate of non-spherical particles and aggregates for all diffusive Knudsen numbers. *Aerosol Science and Technology, 46(11): 1174-1186.*
5. Ouyang, H., **Gopalakrishnan, R.** & Hogan, C. J. (2012), Nanoparticle collisions and growth in the gas phase in the presence of singular attractive potentials. *Journal of Chemical Physics, 137: 064316.*
6. **Gopalakrishnan, R.**, Meredith, M. J., Larriba, C. & Hogan, C. J., Brownian dynamics determination of the bipolar steady charge distribution on sphere and non-spheres in the transition regime. (2013). *Journal of Aerosol Science, 63: 126-145*.
7. **Gopalakrishnan, R.**, Thajudeen, T., Ouyang, H. & Hogan, C. J., The unipolar diffusion charging of arbitrary shaped aerosol particles. (2013). *Journal of Aerosol Science, 64: 60-80*.
8. **Gopalakrishnan, R.**, McMurry, P. H., & Hogan, C. J., The electrical mobilities and scalar friction factors of modest-to-high aspect ratio particles in the transition regime. *Journal of Aerosol Science, 82: 24-39.*
9. **Gopalakrishnan, R.**, McMurry, P. H., & Hogan, C. J., (2015). The Bipolar Diffusion Charging of Nanoparticles: A Review and Development of Approaches for Non-Spherical Particles. *Aerosol Science and Technology, 49(12): 1181-1194*.

10. **Gopalakrishnan, R.**, Kawamura, E., Lichtenberg, A. J., Lieberman, M. A., & Graves, D. B., (2016) Solvated electrons at the atmospheric pressure plasma-water anodic interface *J. Phys. D: Appl. Phys., 49: 295205*. Selected by the Editorial Board of J. Phys. D: Appl. Phys. to feature in Highlights of 2016

11. Wong, C.-S., Goree, J. A., & **Gopalakrishnan, R.,** (2018) Experimental demonstration that a free-falling aerosol particle obeys a fluctuation theorem, *Physical Review E (Rapid Communication), 97: 050601(R)*.

12. Wong, C.-S., **Gopalakrishnan, R.**, and Goree, J. A., (2019) Fluctuation-theorem method of measuring a particle's mass without knowing its shape or density, *Journal of Aerosol Science, 129: 116-123*.

13. Pokharel*, L., Parajuli*, P., Li*, L., Chng*, E. J., and **Gopalakrishnan, R.,** (2019) An ultrasonic feeding mechanism for continuous aerosol generation from cohesive powders. *Aerosol Science and Technology, 53(3): 321-331*.

14. Chahl*, H. S. and **Gopalakrishnan, R.,** (2019) High potential, near free molecular regime Coulombic collisions in aerosols and dusty plasmas, *Aerosol Science and Technology, 53(8): 933-957*.

15. Ahmed*, R., & **Gopalakrishnan, R.**, (2019) Computational study of electrostatic focusing of aerosol nanoparticles using an einzel lens*, Journal of Aerosol Science,* 137: 105443.

16. Chng*, E. J., Watson, A. B., Suresh*, V., Fujiwara, T., Bumgardner, J. D., & **Gopalakrishnan, R.**, (2019) Adhesion of electrosprayed chitosan coatings using silane surface chemistry, *Thin Solid Films*, 137454.

Patent Applications: (* - student advisees of Dr. Gopalakrishnan)

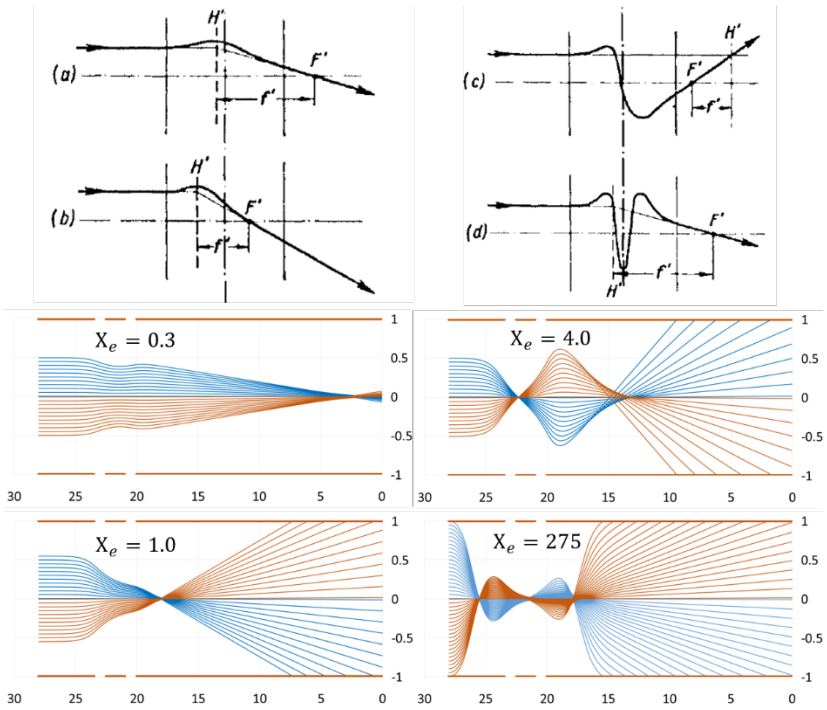
1. **Ranganathan Gopalakrishnan**, Lekhnath Pokharel*, Ewie Jiun Chng*, Jason Scott Presley, "SYSTEMS AND METHODS FOR DISPERSION OF DRY POWDERS", U.S. Prov. App. No. 62/724,699.

Invited Presentations: (* - student advisees of Dr. Gopalakrishnan)

1. Chahl*, H. S., & **Gopalakrishnan, R.**, Langevin dynamics modeling of gas-phase ion-ion recombination rates, 1st Symposium on Nonequilibrium Multiphase Systems, Saint Louis, MO USA December 7-8, 2018, Hosted at Washington University in Saint Louis (WUStL) by the Center for Aerosol Science and Engineering (CASE).
2. **Gopalakrishnan, R.**, Room temperature, solvent-free processing of ceramic coatings using Aerosol Deposition method, Invited seminar at the Department of Mechanical Engineering, University of Maryland – Baltimore County, March 8th, 2019.
3. Vikram Suresh*, Ewe Jiun Chng*, Joel Bumgardner and **Ranganathan Gopalakrishnan**, invited presentation titled "Evaluation of the Adhesion of Electrosprayed and Solution-Cast Chitosan Coatings on Titanium Surfaces", Session D2-TuA2, Abstract #292 at the International Conference on Metallurgical Coatings and Thin Films (ICMCTF) 2019, May 19 – 24, 2019, San Diego, CA, USA.

Currently Active Projects **(updated August 28, 2019)**

Electrostatic focusing of aerosol particles



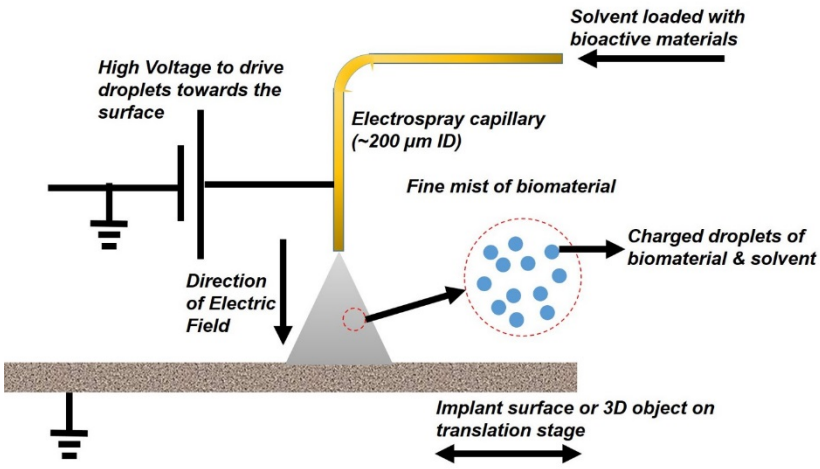
Placing nanoparticles at a desired location is the one of the most challenging issues in the fabrication of 2D and 3D nanostructures and nanodevices. Nanostructures for electronic and plasmonic devices are a major need for the present and upcoming technological advancements. There are numerous applications of nanoparticles in different fields such as biomedical, renewable energy, electronics, environment and health care. Some specific applications could be transistors, sensor applications, data storage, logic circuits and light-emitting devices. This research focuses on applying electrostatic fields to guide and deposit nanoparticles at digitally defined locations for producing individual nanoparticle patterns.

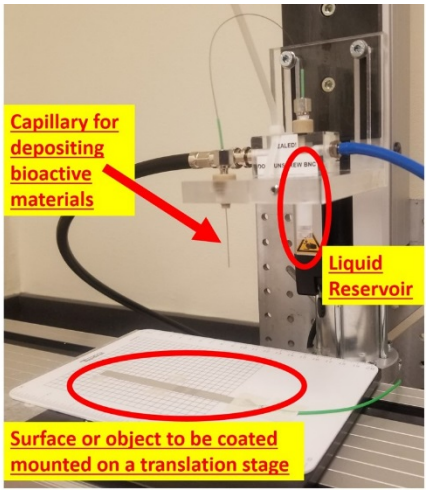
Student(s): Rayhan Ahmed (PhD track)

Publication(s) on this topic:

1. Ahmed*, R., & **Gopalakrishnan, R.**, (2019) Computational study of electrostatic focusing of aerosol nanoparticles using an einzel lens, *Journal of Aerosol Science,* 137: 105443. https://www.sciencedirect.com/science/article/pii/S0021850219305397?via%3Dihub

Biomedical Implant Surface Functionalization via Electrospray AM





Electrospray coating technologies provide an additive manufacturing technique to endow biomedical implant surfaces with new properties to improve their performance by controlled deposition of different materials, compounds and or agents in the form extremely fine nano or micro sized particles on the surface of implant devices under relatively mild conditions. This project focuses on the development of an electrospray additive manufacturing technology to coat dental and orthopedic devices with novel implant coatings that have potential to promote implant integration and prevent/inhibit bacterial attachment. We have developed processes to electrospray several polymer or polymer-ceramic composite coatings in a controlled manner onto implant materials and these coatings have much potential for incorporating drugs and/or growth factors and/or nanoparticles for the effective control of the local delivery of these agents to the implant-tissue interface. For example, these coatings may provide a mechanism for the controlled release of two or more growth factors over time to mimic natural growth factor sequences for healing as well as providing agents that inhibit or prevent bacterial attachment. Development of novel electrospray manufacturing technologies have the potential to add to or enhance implant-tissue interactions that lead to improved implant performance and dramatically reduce infectious complications of implants devices; major challenges to implant device success. This project would have natural interest and collaborations with UTHSC, and the Memphis biomedical implant device and manufacturing companies.

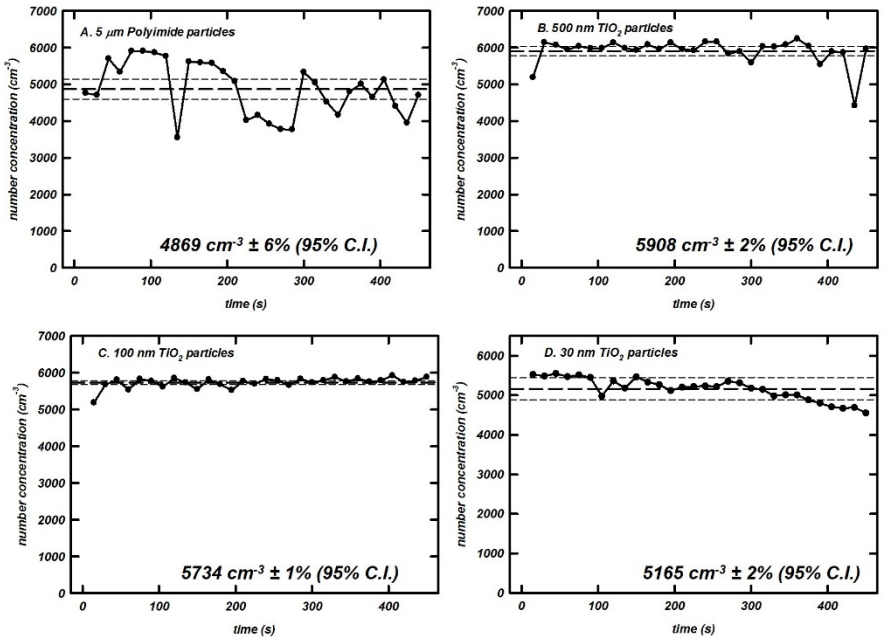
Students: Ewe Jiun Chng (MSME graduate April 2018), Vikram Suresh (PhD track), Andrew Blass Watson (PhD track, BME Dept supervised by Dr. Bumgardner)

Collaborators: Dr. Joel Bumgardner (Biomedical, UoM), Dr. Tomoko Fujiwara (Chemistry, UoM)

Publications on this topic:

1. Chng*, E. J., Watson, A. B., Suresh*, V., Fujiwara, T., Bumgardner, J. D., & **Gopalakrishnan, R.**, (2019) Adhesion of electrosprayed chitosan coatings using silane surface chemistry, *Thin Solid Films*, 137454.
https://www.sciencedirect.com/science/article/pii/S0040609019304821

Ultrasonic dispersion of ceramic powders for additive manufacturing applications



Generation of aerosols from dry cohesive powders: One of the requirements of doing aerosol-based AM research is the necessity of an aerosol source that can feed raw materils in the form of discrete particles (~ few 10's of microns to a few 10's of nanometers in size) at a steady concentration over extended periods of time (~few hours if necessary). In our lab, we have developed an in-house technique to disperse dry powders at a constant rate. The main challenge in doing so is that powders love to stick to surfaces due to their high adhesion energy and are difficult to aerosolize. We have developed a technique that is currently prepared for patenting to generated aerosols from dry powders at high concentrations for AM over long periods of time (see figure).

Students: Lekhnath Pokharel (MSME April 2018), Ewe Jiun Chng, (MSME April 2018), Prashant Parajuli (MSME April 2019), Rayhan Ahmed (PhD track) and Vikram Suresh (PhD track)

Publication(s) on this topic:

1. Pokharel*, L., Parajuli*, P., Li*, L., Chng*, E. J., and **Gopalakrishnan, R.,** (2019) An ultrasonic feeding mechanism for continuous aerosol generation from cohesive powders. *Aerosol Science and Technology, 53(3): 321-331.* https://www.tandfonline.com/doi/full/10.1080/02786826.2018.1559920

Langevin Dynamics modeling of Aerosol and Dusty Plasma processes

Collision dynamics in aerosols and dusty plasmas: the role played by long range potential interactions in the collisions between gas phase entities such as particles, ions, electrons in aerosols and plasma systems is a topic of research that has both fundamental and technological interest. We use Brownian dynamics (BD) simulations to carry out ab initio simulations of particle-ion dynamics and develop descriptive models for collision processes. building on my prior work on this topic from the University of Minnesota, currently we are looking at the collisions between entities dominated by attractive coulombic interactions (for. example collisions between unlike charged particle and ion at a certain pressure of background gas). This problem has a long history in the fields of aerosol and plasma science in the context of particle charging and coagulation and for material synthesis in nanotechnology applications. Recently, we have made significant progress on developing a closed form expression for the collision rate constant between unlike charged particles and are currently preparing it for publication.

External funding of this research:

https://nsf.gov/awardsearch/showAward?AWD_ID=1903432&HistoricalAwards=false

Students: Harjindar Singh Chahl (MSME April 2019), Vikram Suresh (PhD track), Li Li (PhD track)

Publications on this topic:

1. Chahl*, H. S. and Gopalakrishnan, R., (2019) High potential, near free molecular regime Coulombic collisions in aerosols and dusty plasmas, *Aerosol Science and Technology, 53(8): 933-957.* https://www.tandfonline.com/doi/full/10.1080/02786826.2019.1614522

2. Li, L., Chahl, H., and Gopalakrishnan, R., Comparison of the predictions of Langevin Dynamics-based diffusion charging collision kernel models with canonical experiments, In review with *Journal of Aerosol Science*.