

Anoop Rajappan

Research Scientist, Rice University

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EDUCATION

- **Massachusetts Institute of Technology, ScD in Mechanical Engineering** 9/2020
GPA 5.0/5.0, Minor in Applied Mathematics
Thesis: *Polymers and Plastrons: Active and Passive Drag Reduction in Wall-Bounded Turbulent Flows*, advised by Prof. Gareth H. McKinley.
Committee: Prof. Irmgard Bischofberger, Prof. Patrick S. Doyle
- **Massachusetts Institute of Technology, SM in Mechanical Engineering** 9/2017
GPA 5.0/5.0, Thesis: *Skin Friction Drag Reduction in Turbulent Flows using Superhydrophobic Surfaces*, advised by Prof. Gareth H. McKinley
- **Indian Institute of Technology Madras, BTech in Mechanical Engineering** 7/2015
CGPA 9.78/10, Thesis: *Elastocapillary Flow in Polydimethylsiloxane Microchannels*, advised by Prof. Ashis Kumar Sen

RESEARCH EXPERIENCE

- **Research Scientist, Mechanical Engineering, Rice University** 9/2023–present
Soft fluidic circuits for wearables, rheology of thermoset elastomers
Advised by Prof. Daniel J. Preston
- **Postdoctoral Fellow, Rice Academy of Fellows, Rice University** 9/2020–8/2023
Textile-based fluidic logic and energy harvesting for assistive wearables, surface adsorption, wettability, droplet filtration
Advised by Prof. Daniel J. Preston
- **Graduate Researcher, Mechanical Engineering, MIT** 9/2015–8/2020
Superhydrophobic coatings and biopolymeric additives for turbulent drag reduction
Advised by Prof. Gareth H. McKinley
- **Undergraduate Researcher, Mechanical Engineering, IIT Madras** 8/2014–7/2015
Elasto-capillary flows in microfluidic channels made using soft lithography
Advised by Prof. Ashis Kumar Sen

TEACHING EXPERIENCE

- **Guest Lecturer, MECH 472: Thermal Systems Design (Rice University)** 2023
Taught two lectures on analogy between electric and fluid networks for undergraduate students
(Course Instructor: Prof. Daniel J. Preston)

- **Guest Lecturer**, MECH 587: Capillarity and Wetting (Rice University) 2023, 2022, 2021
Lecture on interfacial instabilities for graduate students; evaluation score: 4.8/5.0
(Course Instructor: Prof. Daniel J. Preston)
- **Teaching Assistant**, 2.25: Advanced Fluid Mechanics (MIT) 9/2017–12/2017
Led tutorial sessions and in-person office hours for graduate students; score: 6.4/7.0
(Course Instructor: Prof. Gareth H. McKinley)

ACADEMIC AWARDS AND SCHOLARSHIPS

Postdoctoral Research Excellence Award, Mech. Engineering, Rice University	2023
Junior Fellow, Rice University Academy of Fellows	9/2020–8/2023
School of Engineering Wheelless Fellowship, MIT	9/2015–5/2016
TOEFL India Scholarship, ETS (<i>1 of 10 awardees from India</i>)	2015
Sivasailam Merit Prize, IIT Madras (<i>best undergraduate thesis in mech. eng.</i>)	2015
Banco Foundation Prize, IIT Madras (<i>best academic record in mech. eng.</i>)	2015
TODAI-IIT Undergraduate Scholarship, University of Tokyo	2013, 2012
National Talent Search Scholarship, NCERT, New Delhi, India	2007

PUBLICATIONS IN PEER-REVIEWED JOURNALS

20. **A. Rajappan**, Z. Liu, T. Yap, R. M. Rasheed, “Foam-enabled fluidics for embedded sensing and control in soft robots,” *under review* (2023).
19. T. Yap, **A. Rajappan**, M. D. Bell, R. M. Rasheed, C. J. Decker, D. J. Preston, “Thermally accelerated curing of platinum-catalyzed silicone elastomers,” *Cell Reports Physical Science*, conditionally accepted pending revisions (2023).
18. B. Jumet, Z. A. Zook, A. Yousaf, **A. Rajappan**, D. Xu, T. Yap, N. Fino, Z. Liu, M. K. O’Malley, D. J. Preston, “Fluidically programmed wearable haptic textiles,” *Device* 1, 100059 (2023).
17. M. D. Bell, K. Ye, T. Yap, **A. Rajappan**, Z. Liu, Y. J. Tao, D. J. Preston, “Rapid in situ thermal decontamination of wearable composite textile materials,” *ACS Applied Materials and Interfaces* 15, 44521–44532 (2023).
16. Z. Liu, T. Yap, **A. Rajappan**, R. A. Shveda, R. M. Rasheed, and D. J. Preston, “Mitigating contamination with nanostructure-enabled ultraclean storage,” *Nano Letters* 23, 6315–6322 (2023).
15. C. J. Decker, H. J. Jiang, M. P. Nemitz, S. E. Root, **A. Rajappan**, J. T. Alvarez, J. A. Tracz, L. Wille, D. J. Preston, G. M. Whitesides, “Programmable soft valves for digital and analog control,” *Proceedings of the National Academy of Sciences (PNAS)* 119, e2205922119 (2022).
14. **A. Rajappan**, B. Jumet, R. A. Shveda, C. J. Decker, Z. Liu, T. Yap, V. Sanchez, D. J. Preston, “Logic-enabled textiles,” *Proceedings of the National Academy of Sciences (PNAS)* 119, e2202118119 (2022). *Featured in PNAS “In This Issue”, 119(35), 2022.*
13. R. A. Shveda,* **A. Rajappan**,* T. Yap, Z. Liu, M. D. Bell, B. Jumet, V. Sanchez, D. J. Preston, “A wearable textile-based pneumatic energy harvesting system for assistive robotics,” *Science Advances* 8, eabo2418 (2022). (**denotes equal contribution*)

12. T. Yap, Z. Liu, **A. Rajappan**, T. J. Shimokusu, D. J. Preston, “Necrobotics: biotic materials as ready-to-use actuators,” *Advanced Science*, 2201174 (2022). *Featured on journal back cover, awarded the 2023 Ig Nobel prize in mechanical engineering.*
11. R. M. Rasheed, L. J. Torres, **A. Rajappan**, M. M. Weislogel, D. J. Preston, “Additively manufactured multiplexed inertial coalescence filters,” *Separation and Purification Technology* 292, 120966 (2022).
10. B. Jumet, Z. A. Zook, D. Xu, N. Fino, **A. Rajappan**, M. W. Schara, J. Berning, N. Escobar, M. K. O’Malley, D. J. Preston, “A textile-based approach to wearable haptic devices,” *5th IEEE International Conference on Soft Robotics (RoboSoft)*, 741–746 (2022).
9. Z. Liu, Y. Song, **A. Rajappan**, E. Wang, D. J. Preston, “Temporal evolution of surface contamination under ultra-high vacuum,” *Langmuir* 38, 1252–1258 (2022).
8. **A. Rajappan**, B. Jumet, D. J. Preston, “Pneumatic soft robots take a step toward autonomy,” *Science Robotics* 6, eabg6994 (2021).
7. **A. Rajappan**, G. H. McKinley, “Cooperative drag reduction in turbulent flows using polymer additives and superhydrophobic walls,” *Physical Review Fluids* 5, 114601 (2020).
6. **A. Rajappan**, G. H. McKinley, “Polymers and plastrons in parallel yield enhanced turbulent drag reduction,” *Fluids* 5, 197 (2020).
5. **A. Rajappan**, G. H. McKinley, “Epidermal biopolysaccharides from plant seeds enable biodegradable turbulent drag reduction,” *Scientific Reports* 9, 18263 (2019).
4. **A. Rajappan**, K. Golovin, B. Tobelmann, V. Pillutla, Abhijeet, W. Choi, A. Tuteja, G. H. McKinley, “Influence of textural statistics on drag reduction by scalable, randomly rough superhydrophobic surfaces in turbulent flow,” *Physics of Fluids* 31, 042107 (2019). (**Selected as an “Editor’s Pick” article**)
3. D. Panchanathan, **A. Rajappan**, K. K. Varanasi, G. H. McKinley, “Plastron regeneration on submerged superhydrophobic surfaces using in situ gas generation by chemical reaction,” *ACS Applied Materials and Interfaces* 10, 33684 (2018).
2. D. George, **A. Rajappan**, A. K. Sen, “Elastocapillary powered manipulation of liquid plug in microchannels,” *Applied Physics Letters* 107, 261601 (2015).
1. **A. Rajappan**, A. K. Sen, “Capillary flow enhancement in rectangular polymer micro-channels with a deformable wall,” *Physical Review E* 92, 013024 (2015).

CONFERENCE PRESENTATIONS

7. **A. Rajappan**, D.J. Preston, “A Compact Microporous Foam Resistor for Soft Pneumatic Logic Circuits,” *2nd Conference on Micro Flow and Interfacial Phenomena (μ FIP)*, Irvine, CA, USA (2022).
6. **A. Rajappan**, B. Jumet, R. A. Shveda, C. J. Decker, Z. Liu, T. Yap, V. Sanchez, D. J. Preston, “Logic-enabled textiles,” *5th IEEE International Conference on Soft Robotics (RoboSoft)*, Edinburgh, UK (2022). (**Awarded best presenter for lightning talk at the “New Directions for Simplified Control of Soft Robots” workshop.**)

5. **A. Rajappan**, G. H. McKinley, “Turbulent drag reduction using biopolymers and bio-inspired superhydrophobic surfaces,” *72nd Annual Meeting of the APS Division of Fluid Dynamics*, Seattle WA, USA (2019).
4. **A. Rajappan**, G. H. McKinley, “Plant sourced biopolymers for turbulent drag reduction,” *90th Annual Meeting of the Society of Rheology*, Houston, TX, USA (2018).
3. **A. Rajappan**, G. H. McKinley, “Superhydrophobic and polymer drag reduction in turbulent Taylor-Couette flow,” *70th Annual Meeting of the APS Division of Fluid Dynamics*, Denver, CO, USA (2017).
2. **A. Rajappan**, G. H. McKinley, “Drag reduction using superhydrophobic surfaces,” *MIT Mechanical Engineering Research Exhibition*, Cambridge, MA, USA (2017).
1. A. K. Sen, **A. Rajappan**, “Elastocapillary flow in deformable PDMS microchannels,” *19th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μ TAS)*, Gyeongju, South Korea (2015).

PATENTS

1. A. K. Sen, **A. Rajappan**, “Microfluidic device for enhancing capillary-driven flow in microchannels,” Indian Patent 366293, granted May 7, 2021.
2. C. J. Decker, H. J. Jiang, M. P. Nemitz, S. E. Root, **A. Rajappan**, J. T. Alvarez, J. A. Tracz, L. Wille, D. J. Preston, G. M. Whitesides, “Programmable soft actuators for digital and analog control,” provisional patent application filed with USPTO (2022).
3. B. Jumet, Z. A. Zook, A. N. Yousaf, **A. Rajappan**, D. Xu, T. Yap, N. W. Fino, Z. Liu, M. K. O’Malley, D. J. Preston, “Fluidically programmed wearable haptic textiles,” provisional patent application filed with USPTO (2023).
4. Z. Liu, T. Yap, **A. Rajappan**, R. M. Rasheed, D. J. Preston, “Texture-enabled clean storage,” provisional patent application filed with USPTO (2023).
5. M. D. Bell, D. J. Preston, K. Ye, T. Yap, **A. Rajappan**, Z. Liu, Y. J. Tao, “Wearable composite textile materials for rapid in situ thermal decontamination,” provisional patent application filed with USPTO (2023).

MENTORSHIP EXPERIENCE

Undergraduate students directly supervised:

1. **Esha Ghai**, Rice University ‘23 (9/2020–8/2021)
Research topic: *Micro- and nanoscale surface design for fluid wicking*
2. **Vi Vo**, Rice University ‘23 (9/2021–12/2021)
Research topic: *Layer-based fabrication of fluidic components*

Graduate students mentored:

1. **Rachel A. Shveda**, Rice University (9/2020–5/2021, M.S. student)
Research topic: *Walking energy harvesting for wearable devices*

2. **Te Faye Yap**, Rice University (9/2020–present, Ph.D. student)
Research topic: *Thermal and rheological characterization of elastomer curing*
3. **Marquise D. Bell**, Rice University (9/2020–present, Ph.D. student)
Research topic: *Thermal decontamination of textile-based wearables*
4. **Zhen Liu**, Rice University (9/2020–present, Ph.D. student)
Research topic: *Surface wettability and airborne contamination*
5. **Rawand M. Rasheed**, Rice University (5/2021–present, Ph.D. student)
Research topic: *Fluidic modelling of inertial droplet filters*
6. **Barclay Jumet**, Rice University (7/2021–present, Ph.D. student)
Research topic: *Fluidic modelling of textile pneumatic circuits*
7. **Richard J. Fontenot**, Rice University (7/2021–present, Ph.D. student)
Research topic: *Thermofluidic modelling of heat exchangers*
8. **Irfan Zobayed**, Rice University (1/2023–present, Ph.D. student)
Research topic: *Inertial smoke filtration, textile-based pneumatic actuators*
9. **Adam T. Broshkevitch**, Rice University (1/2023–present, M.S. student)
Research topic: *Fabrication and characterization of heat-sealed textile devices*
10. **Evan S. Noce**, Rice University (1/2023–present, M.S. student)
Research topic: *Wicking through additively manufactured porous media*
11. **Neethu T. Pottackal**, Rice University (1/2023–present, Ph.D. student)
Research topic: *Additive manufacturing of food metamaterials*

PROFESSIONAL ACTIVITIES

Invited talks

1. Spotlight speaker, *Texas Regional Robotics Symposium (TEROS) 2023*, Rice University, Houston, TX, USA (April 14, 2023).

Grant writing experience

1. “Edible mechanical metamaterials via 3D printing for enhanced food properties,” with Neethu T. Pottackal, Te Faye Yap, and Daniel J. Preston (PI), 2023. **Awarded** funding by NSF under the EAGER program.
2. “Edible metamaterials via 3D printing with enhanced food properties,” with Neethu T. Pottackal, Te Faye Yap, Yogesh M. Joshi (PI), and Daniel J. Preston (PI), 2023. **Awarded** funding by the Rice–IITK Strategic Collaboration, Rice University and Indian Institute of Technology Kanpur.
3. “Elucidating the Photocatalytic Oxidation of Adsorbed Asphaltenes on Titania Surfaces,” Daniel J. Preston (PI), 2022. Submitted to the *Welch Foundation Research Grant Program*.
4. “Asphaltene Adsorption on Titania-Coated Surfaces and its Effect on Photocatalytic Efficiency,” Daniel J. Preston (PI), 2021. Submitted to the *American Chemical Society (ACS) PRF DNI Grant Program*.

5. “Plant Sourced Biopolymers for Cost-Effective, Eco-Friendly Drag Reduction in Turbulent Flows,” Gareth H. McKinley (PI), 2018. *Awarded* research funding by *Chevron Corporation*.
6. “Plant-Sourced Biopolymers for Turbulent Drag Reduction in Marine and Naval Applications,” Gareth H. McKinley (PI), 2018. Submitted to *US Office of Naval Research*.

Service as peer-review referee

Advanced Science
 AIP Advances
 Applied Physics Letters
 Biology Open
 IEEE Robotics and Automation Letters*
 Journal of Materials Science
 Materials Advances*
 Micromachines
 Nature Communications*
 Physics of Fluids
 Proceedings of the National Academy of Sciences (PNAS)*
 Science Advances*
 Science Robotics*
 (*Co-reviewer with Prof. Daniel J. Preston)

INDUSTRIAL EXPERIENCE

- **General Electric India Technology Centre**, Bangalore, Karnataka, India Summer 2014
 EID Intern; performed flow modelling of the engine cooling and lubrication systems for locomotives.
- **Hindustan Machine Tools Limited**, Kalamassery, Kerala, India Summer 2013
 Industrial Trainee in a full-fledged machine tool production facility making tool-room and CNC lathes.

LEADERSHIP AND COMMUNITY INVOLVEMENT

- **Advisory Committee Member**, National Service Scheme, IIT Madras Chapter 2013–2014
- **Managerial Team Member**, National Service Scheme, IIT Madras Chapter 2012–2013
- **Student Volunteer**, National Service Scheme, IIT Madras Chapter 2011–2012

ACADEMIC REFERENCES

Prof. Daniel J. Preston *(Postdoctoral advisor)*
 Assistant Professor
 Department of Mechanical Engineering
 Rice University, Houston, TX, USA
 Email: djp@rice.edu

Prof. Gareth H. McKinley
SoE Professor of Teaching Innovation
Department of Mechanical Engineering
Massachusetts Institute of Technology, Cambridge, MA, USA
Email: gareth@mit.edu

(Doctoral advisor)

Prof. Irmgard Bischofberger
Associate Professor
Department of Mechanical Engineering
Massachusetts Institute of Technology, Cambridge, MA, USA
Email: irmgard@mit.edu

(Doctoral thesis committee member)

Prof. Ashis Kumar Sen
Professor
Department of Mechanical Engineering
Indian Institute of Technology Madras, Chennai, TN, India
Email: ashis@iitm.ac.in

(Undergraduate advisor)