PAUL RUMBACH
University of Notre Dame
379 Fitzpatrick Hall
prumbach@nd.edu
574-631-0098

HIGHER EDUCATION

Ph.D. Mechanical Engineering, University of Notre Dame, Notre Dame, IN, 2016.
B.S. Applied Physics, Indiana University, Bloomington, IN, 2010
B.S. Mathematics, Indiana University, Bloomington, IN, 2010

PREVIOUS POSITIONS

2017 to Present - **Associate Teaching Professor** - Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN

2017 to Present - **Research Scientist** - Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN

2015 to 2017 – **Course Instructor** - Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN

2015 to 2017 - **Postdoctoral Research Fellow** - University of Notre Dame (Dr. David Go) , Notre Dame, IN

2011 to 2015 - **Graduate Research Assistant** - University of Notre Dame (Dr. David Go) , Notre Dame, IN

2008 to 2012 - **Undergraduate Research Assistant** - Indiana University Cyclotron Facility (Dr. Sokol and Dr. Kaiser), Bloomington, IN

TEXTBOOKS

P. Rumbach, *Undergraduate Lectures in Measurements and Data Analysis*, 2021, BreviLiber.

REFEREED PUBLICATIONS

[1] O. Dubrovski, J. Yang, F. Veloso, D. B. Go, H.-C. Chang, and **P. Rumbach**, “Universal interfacial dynamics due to resonant coupling between electron plasma patterns and capillary wave dynamics,” *Physical Review Letters* (2024).

[2] D. C. Martin, D. T. Elg, H. E. Delgado, H. M. Nguyen, **P. Rumbach**, D. M. Bartels, and D. B. Go, *Langmuir*, **40** (28), 14224-14232 (2024).

[3] D. C. Martin, D. M. Bartels, **P. Rumbach**, and D. B. Go, “Experimental confirmation of solvated electron concentration and penetration scaling at a plasma-liquid interface,” *Plasma Sources Science and Technology* (2021).

[4] H. E. Delgado, D. Elg, D. M. Bartels, **P. Rumbach**, and D. B. Go, “Chemical Analysis of Secondary Electron Emission from a Water Cathode at the Interface with a Nonthermal Plasma,” *Langmuir*, **36**, 1156-1164 (2020).

[5] **P. Rumbach**, A. E. Lindsay, and D. B. Go, "Turing patterns on a plasma-liquid interface," *Plasma Sources Science and Technology*, **28**, 105014 (2019).

[6] H. E. Delgado, R. C. Radomsky, D. C. Martin, D. M. Bartels, **P. Rumbach**, and D. B. Go, "Effect of Competing Oxidizing Reactions and Transport Limitation on the Faradaic Efficiency in Plasma Electrolysis," *Journal of The Electrochemical Society* , **166**, E181-E186 (2019).

[7] **P. Rumbach**, D. M. Bartels, and D. B. Go, "The penetration and concentration of solvated electrons and hydroxyl radicals at a plasma-liquid interface," *Plasma Sources Science and Technology*, **27**, 115013 (2018).

[8] P. Mehta, P. Barboun, F. A. Herrera, J. Kim, **P. Rumbach**, D. B. Go, J. C. Hicks, and W. F. Schneider, "Overcoming ammonia synthesis scaling relations with plasma-enabled catalysis," *Nature Catalysis*, **1**, 269–275 (2018).

[9] H. E. Delgado, **P. Rumbach**, D. M. Bartels and D.B. Go, "Total Internal Reflection Absorption Spectroscopy (TIRAS) for the Detection of Solvated Electrons at a Plasma-liquid Interface," *J. Vis. Exp.* (131), e56833, doi:10.3791/56833 (2018).

[10] **P. Rumbach**, J. P. Clarke, and D.B. Go, "Electrostatic Debye Layer formed at a Plasma-liquid Interface," *Phys. Rev. E*., **95**, 053203 (2017).

[11] **P. Rumbach** and D.B. Go, "Perspectives on Plasmas in Contact with Liquids for Chemical Processing and Materials Synthesis," *Topics in Catalysis,* **60***,* 799-811 (2017).

[12] **P. Rumbach**, R. Xui, and D.B. Go, "Electrochemical Production of Oxalate and Formate from CO2 by Solvated Electrons Produced Using an Atmospheric-Pressure Plasma," *J. Electrochem. Soc.,* **163**, F1157 (2016).

[13] **P. Rumbach**, D.M. Bartels, R.M. Sankaran, and D.B. Go, "The effect of air on solvated electron chemistry at a plasma/liquid interface," *J. Phys. D: Appl. Phys*. **48**, 424001 (2015).

[14] **P. Rumbach**, D.M. Bartels, R.M. Sankaran, and D.B. Go, "The solvation of electrons by an atmospheric-pressure plasmas," *Nature Communications*, **6**, 7248 (2015).

[15] **P. Rumbach**, Y. Li, S. Martinez, T. J. Twahirwa, and D. B. Go, "Experimental study of electron impact ionization in field emission-driven microdischarges," *Plasma Sources Sci. Technol.* **23**, (2014).

[16] **P. Rumbach**, N. Griggs, R. M. Sankaran, and D. B. Go, "Visualization of Electrolytic Reactions at a Plasma-Liquid Interface," *IEEE T. Plasma Sci.*, (2014).

[17] **P. Rumbach**, M. Witzke, R.M. Sankaran, & D.B. Go, "Decoupling interfacial reactions between plasmas and liquids: Charge transfer vs. plasma neutral reactions," *J. Am. Chem. Soc*. **135**, (2013).

[18] Y. Li, R. Tirumala, **P. Rumbach**, and D. B. Go, "The coupling of ion-enhanced field emission and the discharge during microscale breakdown at moderately high pressures," *IEEE T. Plasma Sci.*, **41**, 24-35 (2013).

[19] M. Witzke, **P. Rumbach**, D. B. Go, and R. M. Sankaran, "Evidence for the electrolysis of water by atmospheric-pressure plasmas formed at the surface of aqueous solutions," *J. Phys. D: Appl. Phys*. **45**, 442001 (2012).

[20] **P. Rumbach** and D. B. Go, "Fundamental properties of field emission-driven direct current microdischarges," *J. Appl. Phys.* **112**, 103302 (2012).

INVITED LECTURES AND ADDRESSES

[1] **2019, International Conference on Plasma Science** – "Theory for Self-organized Patterns on Liquid Anodes."

[2] **2016, International Workshop on Plasma Cancer Treatment** – "Measurements of Solvated Electrons Produced by Low Temperature Plasma."

[3] **2015, SciX** – "Direct Measurements of Solvated Electrons at a Plasma-Liquid Interface"

[4] **2015, Electrostatics Society of America** – "Direct Optical Measurements of Solvated Electrons at a Plasma-liquid Interface"

TEACHING HISTORY

Fall 2024 – AME20216 – Lab I (89 students)

Fall 2024 – AME40451 – Aerospace Dynamics (52 students)

Fall 2024 – AME47560 – Independent Undergraduate Design (4 students)

Spring 2024 – AME20216 – Lab I (69 students)

Spring 2024 – AME30358 – Mechatronics Lab (16 students)

Spring 2024 – AME40453 – Automations and Controls Lab (14 students)

Spring 2024 – AME47560 – Independent Undergraduate Design (5 students)

Fall 2023 – AME20216 – Lab I (88 students)

Fall 2023 – AME40451 – Aerospace Dynamics (34 students)

Fall 2023 – AME47560 – Independent Undergraduate Design (1 student)

Spring 2023 – AME20216 – Lab I (70 students)

Spring 2023 – AME30358 – Mechatronics Lab (9 students)

Spring 2023 – AME40453 – Automations and Controls Lab (7 students)

Fall 2022 – EG35101 – Innovation Projects (4 students)

Fall 2022 – AME20216 – Lab I (86 students)

Fall 2022 – AME20217 – Lab II (49 students)

Fall 2022 – EG35101 – Innovation Projects (3 students)

Fall 2022 – AME47560 – Independent Undergraduate Design (1 student)

Spring 2022 – AME20216 – Lab I (43 students)

Spring 2022 – AME20217 – Lab II (67 students)

Spring 2022 – AME40453 – Automations and Controls Lab (10 students)

Fall 2021 – AME20216 – Lab I (86 students)

Fall 2021 – AME20217 – Lab II (49 students)

Fall 2021 – AME47560 – Independent Undergraduate Design (2 student)

Spring 2021 – AME20216 – Lab I (43 students)

Spring 2021 – AME20217 – Lab II (67 students)

Spring 2021 – AME40453 – Automations and Controls Lab (10 students)

Fall 2020 – AME20216 – Lab I (84 students)

Fall 2020 – AME20217 – Lab II (80 students)

Spring 2020 – AME20216 – Lab I (56 students)

Spring 2020 – AME20217 – Lab II (69 students)

Spring 2020 – AME40453 – Automations and Controls Lab (9 students)

Spring 2020 – AME47560 – Independent Undergraduate Design (1 student)

Fall 2019 – AME20216 – Lab I (91 students)

Fall 2019 – AME20217 – Lab II (79 students)

Fall 2019 – AME47560 – Independent Undergraduate Design (3 students)

Spring 2019 – AME20216 – Lab I (70 students)

Spring 2019 – AME20217 – Lab II (68 students)

Fall 2018 – AME20216 – Lab I (75 students)

Fall 2018 – AME20217 – Lab II (54 students)

Spring 2018 – AME20216 – Lab I (72 students)

Spring 2018 – AME20217 – Lab II (40 students)

Fall 2017 – AME20216 – Lab I (84 students)

Fall 2017 – AME20213 – Measurements & Data Analysis (80 students)

Spring 2017 – AME20213 – Measurements & Data Analysis (58 students)

Fall 2016 – AME20213 – Measurements & Data Analysis (89 students)

Spring 2016 – AME20213 – Measurements & Data Analysis (96 students)

Fall 2015 – AME20213 – Measurements & Data Analysis (70 students)

COURSE DEVELOPMENT

Spring 2023 – Developed and implemented a new laboratory course titled AME30358 – Mechatronics Lab.

Spring 2020 – Developed and implemented a new laboratory course titled AME40453 – Automations and Controls Lab.

CONFERENCE PRESENTATIONS

[1] **2024, American Vacuum Society** – "Noncapillary Liquid Surface Waves Generated by Self-organized Plasma Patterns"

[2] **2018, International Conference on Plasma Science** – "Theoretical Analysis of Free Radical Chemistry at a Plasma-liquid Interface."

[3] **2017, International Conference on Plasma Science** – "The Interfacial Debye Layer of a Liquid Anode Glow Discharge."

[4] **2016, ArtPrize** – "Steelheads," oil on canvas, entry #63500.

[5] **2015, American Vacuum Society Prairie Chapter Symposium** – "Optical Measurements of Solvated Electrons at a Plasma-Liquid Interface"

[6] **2014, American Vacuum Society** – "Understanding charge transfer reactions at a plasma-liquid interface"

[7] **2014, Society of Engineering Science Annual Technical Meeting** – "Field emission-driven microdischarges"

[8] **2014, Electrostatics Society of America** – "Gas discharge processes at micrometer scales"
[9] **2013, American Vacuum Society** – "Deciphering Gas-Phase and Solution-Phase Reactions Initiated by Plasmas at the Surface of Aqueous Solutions"
[10] **2013, Electrostatics Society of America** – "Plasma-liquid interactions: Separating electrolytic reactions from plasma/gas phase reactions"
[11] **2012, American Vacuum Society** – "Reactions at the Interface of Plasmas and Aqueous Electrodes: Identifying the Role of Electrons "
[12] **2012, Gaseous Electronics Conference** – "Field Emission-Driven Townsend Microdischarges"
[13] **2012, Mechanisms of Vacuum Arcs** – "Field Emission-Driven Microdischarges "
[14] **2011, Gaseous Electronics Conference** – "Current-Voltage Measurements for DC Microplasmas with Gap Sizes Less than 10 μm"

SCHOLARSHIPS AND FELLOWSHIPS

2016 - **ND Energy Postdoctoral Fellowship**

DISTINCTIONS, HONORS, AND AWARDS

2025 - **Rev. Edmund P. Joyce, C.S.C., Award for Excellence in Teaching**

2025 - **AME Faculty Award**

2015 - **Electrostatics Society of America Conference** - First Place Student Presentation Award

2014 - **AVS Plasma Science and Technology Division** - Coburn and Winters Award

2014 - **Electrostatics Society of America Conference** - First Place Student Presentation Award

2013 - **University of Notre Dame** - Kaneb Center Outstanding Graduate Student Teacher/TA Award

2013 - **Electrostatics Society of America Conference** - First Place Student Presentation Award

GRANTS AND SPONSORED PROGRAMS

2020, Teaching Resilience and Recovery Grant – Obtained $8,800 in additional funding to purchase equipment for conducting remote lab exercises during the COVID-19 pandemic.

INTERNAL SERVICE ACTIVITIES

2022 – 2025, Faculty Advisor for Mars Rover Club (Domer Rover) – Advised undergraduate club aimed at designing and building a Mars rover vehicle for the University Rover Challenge Competition.

2022 - 2025, College Council – Served on the College Council for the College of Engineering

2024, Ph.D. Candidacy for Ibu Akintola – Served on Ph.D. candidacy committee

2024, Ph.D. Defense for Daniel Martin – Served on Ph.D. defense committee.

2022, Ph.D. Defense for Jinyu Yang – Served on Ph.D. defense committee.

2020, Slatt Fellowship Project – Served as faculty adviser for Akin Adegoke's project titled "Integrating Photovoltaic Infrastructure and Agriculture".

2020, Building Bridges Mentoring Program – Served as a faculty mentor.

2020, Mary E. Galvin Science & Engineering Scholars Program – Served as a faculty mentor.

2020, Ph.D. Candidacy Exam for Jinyu Yang – Served on candidacy committee.

PROFESSIONAL MEMBERSHIPS

Institute of Electrical and Electronics Engineers (IEEE)