

# Thomas C. Underwood

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Aerospace Engineering & Engineering Mechanics, The University of Texas at Austin  
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## PROFESSIONAL EXPERIENCE

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**Assistant Professor, The University of Texas at Austin** 2021-Present  
*Department of Aerospace Engineering & Engineering Mechanics*

**Affiliated Faculty, The University of Texas at Austin** 2021-Present  
*Texas Materials Institute*

## EDUCATION & TRAINING

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**Harvard University, Department of Chemistry and Chemical Biology** 2019-2020  
*Postdoctoral Research Fellow*  
◊ Advisor: Professor George M. Whitesides

**Stanford University, Department of Mechanical Engineering** 2014-2019  
*Ph.D. in Mechanical Engineering (3.99/4.00)*  
◊ Advisor: Professor Mark A. Cappelli  
*M.S. in Mechanical Engineering*

**University of Florida, Department of Nuclear Engineering/ Physics** 2009-2014  
*B.S. in Nuclear Engineering (4.00/4.00)*  
*B.S. in Physics (4.00/4.00)*

## AWARDS

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DURIP - AFOSR Propulsion & Power 2023  
DURIP - ONR High Power Microwaves 2023  
AFOSR Young Investigator Award 2021  
John R. MacDonald Memorial Fellowship - Stanford University 2018-2019  
Student Excellence Award Finalist - Gaseous Electronics Conference 2018  
Best Poster - Stewardship Science Academic Programs Symposium 2015 and 2017  
National Defense Science and Engineering Graduate (NDSEG) Fellowship 2014-2017  
National Science Foundation Graduate Research Fellowship (NSFGRF) 2014, Declined  
University of Florida Anderson Scholar 2011

## INTERESTS

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*Research* I am interested in understanding how the chemistry and dynamics of plasmas can be leveraged to address challenges in space, propulsion, and the synthesis of clean and environmentally sustainable fuels. My research lies at the intersection of plasma physics, fluid mechanics, and chemistry.

*Teaching* My teaching interests center around the education of students to meet society's rising demand to access space and utilize clean and environmentally sustainable fuels. I have experience teaching both fundamental and applied courses in fluid mechanics, gas dynamics, aerodynamics, propulsion, and plasma physics. I am also interested in teaching experimental laboratory classes at the undergraduate and graduate level.

## SELECT JOURNAL PUBLICATIONS

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- [1] **T. C. Underwood**, W. Riedel, and M. A. Cappelli, "Dual Mode Operation of a Hydromagnetic Plasma Thruster to Achieve Tunable Thrust and Specific Impulse," *Journal of Applied Physics*, 130, 133301, 2022.

- [2] **T. C. Underwood**, K. T. K. Loebner, V. A. Miller, and M. A. Cappelli, “Schlieren diagnostic for cinematic visualization of dense plasma jets,” *Experiments in Fluids*, vol. 61, pp. 1-13, 2020.
- [3] **T. C. Underwood**, K. T. K. Loebner, V. A. Miller, and M. A. Cappelli, “Dynamic Stabilization of Current-Driven Plasma Jets,” *Nature Scientific Reports*, vol. 9, no. 1, p. 2588, 2019.
- [4] R. A. C. Quinones, **T. C. Underwood**, and M. A. Cappelli, “Laser-Produced Gaseous Plasmonic Resonators,” *Physics of Plasmas*, vol. 25, no. 11, p. 113501, 2018.
- [5] K. T. K. Loebner, **T. C. Underwood**, and M. A. Cappelli, “Evidence of Branching Phenomena in Current-Driven Ionization Waves,” *Phys. Rev. Lett.*, vol. 115, p. 175001, 2015.

## OTHER JOURNAL PUBLICATIONS

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- [1] A. Davletshin, **T. C. Underwood**, and W. Song, “A Bidirectional Soft Diode for Artificial Systems,” *Adv. Funct. Mater.*, 2200658, 2022.
- [2] S. Kendre, L. Whiteside, T. Fan, J. Tracz, G. Teran, **T. C. Underwood**, et al., “The Soft Compiler: A Web-Based Tool for the Design of Modular Pneumatic Circuits for Soft Robots.” *IEEE Robotics and Automation Letters*, 7, no. 3, 6060-6066, 2022.
- [3] R. A. C. Quinones, **T. C. Underwood**, and M. A. Cappelli, “Tunable Surface Plasmon Resonance in Laser-Induced Plasma Spheroids” *Plasma Sources Science and Technology*, 30.4, 045010, 2021.
- [4] **T. C. Underwood**, V. Subramaniam, W. Riedel, L. L. Raja, and M. A. Cappelli, “Effects of flow collisionality on ELM replication in plasma guns,” *Fusion Engineering and Design*, vol. 144, pp. 97 – 106, 2019.
- [5] V. Subramaniam, **T. C. Underwood**, L. L. Raja, and M. A. Cappelli, “Computational and experimental investigation of plasma deflagration jets and detonation shocks in coaxial plasma accelerators,” *Plasma Sources Science and Technology*, 2018.
- [6] D. R. Biggs, **T. C. Underwood**, and M. A. Cappelli, “Predictive modeling of plasmas for gaseous plasmonics,” *Plasma Sources Science and Technology*, vol. 27, no. 7, p. 075005, 2018.
- [7] **T. C. Underwood**, K. T. K. Loebner, and M. A. Cappelli, “A plasma deflagration accelerator as a platform for laboratory astrophysics,” *High Energy Density Physics*, vol. 23, pp. 73 – 80, 2017.
- [8] K. T. K. Loebner **T. C. Underwood**, T. Mouratidis, and M. A. Cappelli, “Radial magnetic compression in the expelled jet of a plasma deflagration accelerator,” *Applied Physics Letters*, vol. 108, no. 9, p. 094104, 2016.
- [9] K. T. K. Loebner, **T. C. Underwood**, B. C. Wang, and M. A. Cappelli, “Damage morphologies in targets exposed to a new plasma deflagration accelerator for elm simulation,” *IEEE Transactions on Plasma Science*, vol. 44, pp. 1534–1540, Sept 2016.
- [10] K. T. K. Loebner, **T. C. Underwood**, and M. A. Cappelli, “A fast rise-rate, adjustable-mass-bit gas puff valve for energetic pulsed plasma experiments,” *Review of Scientific Instruments*, vol. 86, no. 6, p. 063503, 2015.
- [11] **T. C. Underwood**, S. Roy, and B. Glaz, “Physics based lumped element circuit model for nanosecond pulsed dielectric barrier discharges,” *Journal of Applied Physics*, vol. 113, no. 8, p. 083301, 2013.

## PATENTS

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- [1] **T. C. Underwood** and W. Song, “Separation of Lithium from Aqueous Sources,” *University of Texas at Austin Office of Technology Commercialization*, U.S. Patent Application No. 17/729,268, 2022.

- [2] H. Jiang, M. El-Rahman, L. Brazaca, **T. C. Underwood**, J. Sakamoto, J. Bell, G. M. Whitesides, “Methods and Systems for Generating Liquid Motion,” *Harvard University Office of Technology Development*, U.S. Provisional Patent Application No. 63/417,082, 2022.
- [3] H. Jiang, **T. C. Underwood**, J. Bell, M. Draz, C. Abrahamsson, S. Root, and G. M. Whitesides, “Harvesting Electrostatics to Perform Chemical Reactions,” *Harvard University Office of Technology Development*, U.S. Provisional Patent Application No. 63/380,142, 2022.
- [4] W. Song and **T. C. Underwood**, “Multifunctional Soft Diode for Artificial Systems,” *University of Texas at Austin Office of Technology Commercialization*, U.S. Provisional Patent Application No. 63/326,489, 2022.

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#### CONFERENCE PRESENTATIONS & PAPERS

- [1] K. Prathivadi, J. Dye and **T. C. Underwood**, “Characterization of an Air-Breathing Deflagration Thruster,” in *AIAA SciTech*, 2023.
- [2] J. Dye, C. Nallapareddy, and **T. C. Underwood**, “Chirped Terahertz Time-Domain Spectroscopy for Reactive Plasma Flows,” in *AAIAA SciTech*, 2023.
- [3] **T. C. Underwood**, “Stabilization Effects in Hydromagnetic Plasma Flows,” in *AIAA SciTech*, 2023.
- [4] K. Balan and **T. C. Underwood**, “Suppressing Dendritic Growth in Electrochemical Systems using Magnetic Fields,” in *APS Division of Fluid Dynamics*, 2022.
- [5] **T. C. Underwood**, “Engineering Hydromagnetic Stability Using Shear Flows in Pulsed Plasma Thrusters,” in *International Electric Propulsion Conference, International Electric Propulsion Conference*, IEPC-2022-568, 2022.
- [6] **T. C. Underwood**, “Air Breathing Dual Mode Plasma Thruster,” in *International Electric Propulsion Conference, International Electric Propulsion Conference*, IEPC-2022-43, 2022.
- [7] C. Nallapareddy, **T. C. Underwood**, “The Selectivity-Conversion Tradeoff in Partial Methane Oxidation Using Non-Equilibrium Plasmas,” in *APS Gaseous Electronics Conference*, 2022.
- [8] D. Hood-McFadden, **T. C. Underwood**, “Separating Critical Materials using an Electromagnetic Centrifuge,” in *APS Gaseous Electronics Conference*, 2022.
- [9] **T. C. Underwood**, K. T. K. Loebner, V. A. Miller, and M. A. Cappelli, “Student excellence award finalist: Evidence of stabilization in current-driven plasma jets,” in *APS Gaseous Electronics Conference*, 2018.
- [10] **T. C. Underwood**, V. Subramaniam, W. Riedel, L. L. Raja, and M. A. Cappelli, “Flow collisionality effects in plasma guns for simulating fusion wall response to disruption events,” in *APS Division of Plasma Physics Meeting*, 2018.
- [11] **T. C. Underwood**, W. Riedel, F. Righetti, and M. A. Cappelli, “Studying the use of pulsed plasma jets for simulating fusion wall response to disruptions,” in *Stewardship Science Academic Programs Symposium*, 2017.
- [12] **T. C. Underwood**, J. Rodriguez, K. T. K. Loebner, and M. A. Cappelli, “Cinematic characterization of convected coherent structures within an continuous flow z-pinch,” in *Division of Plasma Physics Meeting*, 2017.
- [13] **T. C. Underwood**, W. Riedel, and M. A. Cappelli, “Cinematic characterization of convected coherent structures within an continuous flow z-pinch,” in *HEDP Summer School*, 2017.
- [14] W. Riedel, **T. C. Underwood**, F. Righetti, and M. A. Cappelli, “Understanding the effect of gas dynamics in plasma gun performance for simulating fusion wall response to disruption events,” in *Division of Plasma Physics Meeting*, 2017.

- [15] **T. C. Underwood**, K. T. K. Loebner, and M. A. Cappelli, “The characterization of a plasma deflagration accelerator for simulating fusion wall response to disruptions,” in *Stewardship Science Academic Programs Symposium*, 2016.
- [16] **T. C. Underwood**, K. T. K. Loebner, and M. A. Cappelli, “Emulation of astrophysical jets with a plasma deflagration accelerator,” in *High Energy Density Laboratory Astrophysics*, 2016.
- [17] **T. C. Underwood**, K. T. K. Loebner, and M. A. Cappelli, “Experimental characterization of a plasma deflagration accelerator for simulating fusion wall response to disruption events,” in *APS Division of Plasma Physics Meeting*, 2016.
- [18] R. Colon Quinones, **T. C. Underwood**, and M. A. Cappelli, “Spectroscopic studies of laser produced plasma metasurfaces,” in *APS Division of Plasma Physics Meeting*, 2016.
- [19] R. Colon Quinones, **T. C. Underwood**, and M. A. Cappelli, “Experimental validation of plasma metasurfaces as tunable thz reflectors,” in *APS Division of Plasma Physics Meeting*, 2016.
- [20] K. T. K. Loebner, **T. C. Underwood**, and M. A. Cappelli, “Schlieren cinematography of current driven plasma jet dynamics,” in *APS Division of Plasma Physics Meeting*, 2016.
- [21] R. A. C. Quinones, **T. C. Underwood**, and M. A. Cappelli, “On the use of plasma metasurfaces as tunable thz wave reflectors,” in *IEEE International Conference on Plasma Science (ICOPS)*, 2016.
- [22] K. T. K. Loebner, **T. C. Underwood**, and M. A. Cappelli, “Plume characterization of a high directed energy plasma source for material interaction studies,” in *Stewardship Science Academic Programs Symposium*, 2015.
- [23] K. T. K. Loebner, **T. C. Underwood**, T. Mouratidis, and M. A. Cappelli, “Spectroscopic study of a pulsed high-energy plasma deflagration accelerator,” in *APS Division of Plasma Physics Meeting*, 2015.
- [24] B. Wang, R. Colon Quinones, D. Biggs, **T. C. Underwood**, A. Lucca Fabris, and M. A. Cappelli, “Microwave photonic bandgap devices with active plasma elements,” in *APS Division of Plasma Physics Meeting*, 2015.
- [25] K. T. K. Loebner, **T. C. Underwood**, A. L. Fabris, M. A. Cappelli, and J. J. Szabo, “Plume characterization of gas-fed pulsed plasma deflagration thrusters,” *International Electric Propulsion Conference*, 2015.

## AWARDED GRANTS

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DURIP: Single-Shot Chirped THz Spectroscopy for Air-Breathing Electric Propulsion <i>Source: Air Force Office of Scientific Research</i> <i>Role: PI</i>	1/23-12/23
DURIP: Plasma Diagnostics for High Power Microwaves <i>Source: Office of Naval Research</i> <i>Role: PI</i>	1/23-12/23
Air-breathing Magneto-deflagration Propulsion for Sustained Very Low Earth Orbit <i>Source: Air Force Office of Scientific Research Young Investigator Program (YIP)</i> <i>Role: PI</i>	1/21-12/23
UT/SwRI Energize Program: Plasma Catalytic Conversion of Methane to Hydrogen <i>Source: UT Austin Energy Institute</i> <i>Role: PI</i>	6/22-6/23
Ammonia Reforming to Hydrogen using Non-Equilibrium Plasma Discharges <i>Source: UT Austin Energy Institute</i> <i>Role: co-PI</i>	6/22-6/23

Studies in the Chemistry of Elementary Processes on the Prebiotic Earth <i>Source: Simons Foundation</i> <i>Role: co-PI</i>	6/21-6/23
Li Extraction through Electromagnetically-Controlled Dendritic Electrodeposition <i>Source: DOE Energy Efficiency and Renewable Energy</i> <i>Role: co-PI</i>	8/21-8/24
Sustainable Transition: Economic Recovery of Rare Earth Elements (REEs) <i>Source: UT Austin Energy Institute</i> <i>Role: co-PI</i>	1/20-12/21

## INVITED TALKS

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- [1] “Air-Breathing Magneto-Deflagration Propulsion for Sustained Very Low Earth Orbit.” APS Gaseous Electronics Conference, 2023.
- [2] “Beyond Miller-Urey: Role of Lightning in the Origin of Life.” Center for Planetary Habitability, The University of Texas at Austin, 2022.
- [3] “Plasma Centrifuge to Separate Critical Materials.” Energy Week, The University of Texas at Austin, 2022.
- [4] “Air-Breathing Electric Propulsion.” Fluid Mechanics Seminar, The University of Texas at Austin, 2021.
- [5] “Plasmas at the Origin of Life.” Princeton Plasma Physics Laboratory, Princeton University, 2021 (*Cancelled Due to COVID*).
- [6] “Dynamic Stabilization of Current-Driven Plasma Jets.” Department of Aerospace Engineering and Engineering Mechanics, The University of Texas at Austin, 2019.
- [7] “Dynamic Stabilization of Current-Driven Plasma Jets.” University of Toronto Institute for Aerospace Studies, University of Toronto, 2018.
- [8] “Ultra-High Speed Neutral Jets and their Interactions with Materials Generating Extreme Conditions.” HTGL Research Seminar, Department of Mechanical Engineering, Stanford University, 2017.
- [9] “Schlieren Imaging and Spectroscopic Analysis of a Hypervelocity Plasma Jet.” HTGL Research Seminar, Department of Mechanical Engineering, Stanford University, 2016.

## COURSES TAUGHT

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ASE 120K: Low-Speed Aerodynamics Lab, The University of Texas at Austin <i>Role: Primary Instructor</i>	Fall 2023 (Planned)
ASE 162K: High-Speed Aerodynamics Lab, The University of Texas at Austin <i>Role: Primary Instructor</i>	Fall 2023 (Planned)
ASE 389: Advanced Topics in Plasmas, The University of Texas at Austin <i>Role: Primary Instructor</i> <i>Teaching Evaluation: 4.6/5</i>	Fall 2021-2022
ASE 320: Low-Speed Aerodynamics, The University of Texas at Austin <i>Role: Primary Instructor</i> <i>Teaching Evaluation: 4.6/5</i>	Spring 2021-2022
ME 362A: Physical Gas Dynamics, Stanford University <i>Primary Instructor: Mark Cappelli</i> <i>Role: Teaching Assistant/ Co-Instructor</i>	Fall 2017

## INDUSTRIAL/RESEARCH EXPERIENCE

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Lawrence Livermore National Laboratory <i>High Energy Density Scholar</i>	Summer 2018
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NASA Langley Research Center <i>Langley Aerospace Research Student Scholar (LARSS)</i>	<i>Summer 2014</i>
Princeton Plasma Physics Laboratory <i>National Undergraduate Fellow</i>	<i>Summer 2012</i>
U.S. Army Research Laboratory <i>Vehicle Technology Directorate</i>	<i>Summer 2011</i>

STUDENTS ADVISED

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Sankarsh Rao, <i>Undergraduate, The University of Texas at Austin</i>	<i>2022-Present</i>
Anikait Kolluri, <i>Undergraduate, The University of Texas at Austin</i>	<i>2022-Present</i>
Harsha Rajesh, <i>Undergraduate, The University of Texas at Austin</i>	<i>2022-Present</i>
Mark Dunn, <i>Undergraduate, The University of Texas at Austin</i>	<i>2022-Present</i>
Drue Hood-McFadden, <i>PhD Student, The University of Texas at Austin</i>	<i>2021-Present</i>
Kirutiga Balan, <i>PhD Student, The University of Texas at Austin</i>	<i>2021-Present</i>
Alyson Jia, <i>Undergraduate, The University of Texas at Austin</i>	<i>2021-Present</i>
Harsha Rajesh, <i>Undergraduate, The University of Texas at Austin</i>	<i>2021-Present</i>
Charan Nallapareddy, <i>PhD Student, The University of Texas at Austin</i>	<i>2020-Present</i>
Weijia Bian, <i>PhD Student, The University of Texas at Austin</i>	<i>2020-2021</i>
Jesse Rodríguez, <i>Undergraduate, Oregon State University</i>	<i>2017</i>
Theodore Mouratidis, <i>Undergraduate, MIT</i>	<i>2015</i>

SERVICE

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Session Chair, AIAA SciTech	<i>2023</i>
Reviewer, NSF CBET	<i>2022</i>
Session Chair, International Electric Propulsion Conference	<i>2022</i>
Reviewer, AFOSR MURI	<i>2021</i>
Reviewer, AIP Advances	<i>2020-present</i>
Reviewer, Experiments in Fluids	<i>2019-present</i>
Reviewer, Experiments in Fluids	<i>2019-present</i>
Undergraduate and Graduate Student Mentor, Stanford University	<i>2017-present</i>
Reviewer, Journal of Applied Physics	<i>2017-present</i>

SOCIETY AFFILIATION

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Member, American Physical Society	<i>2014-present</i>
Member, American Institute of Aeronautics and Astronautics	<i>2019-present</i>