MONIQUE MCCLAIN

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Education

Purdue University
DOCTOR OF PHILOSOPHY — June 2020
MASTER OF SCIENCE, AERONAUTICS & ASTRONAUTICS — August 2018

University of California, San Diego
BACHELOR OF SCIENCE, AEROSPACE ENGINEERING — June 2016

Skills

COMPUTER: MATLAB, CHEMKIN, CAD software (Inventor, SolidWorks, Fusion), LABVIEW, ANSYS Fluent, RPA, COSILAB, C/C++, Linux, LaTeX, RocFire, slicing software (Slicer 3D, Cura, Simplify3D)
EXPERIMENT: MicroCT, high pressure combustion experiments, solid rocket static fire experiments, flexural strength testing, friction testing, viscosity testing (rotational viscometer and capillary rheometer), DSC/TGA, opposed flow burner
OTHER: Fused filament fabrication (FFF), direct ink write (DiW), and vibration assisted printing (VAP) additive manufacturing methods

Work Experience

RESEARCH SCIENTIST – Purdue University – August 2020 – Present

- Partnering with researchers at the Oakridge Manufacturing Demonstration Facility to work in research areas related to Big Area Additive Manufacturing

GRADUATE RESEARCH ASSISTANT – Purdue University – August 2016 – June 2020

- Investigate effect of catalysts on the combustion of additively manufactured layered solid propellant
- Compare layered solid propellant models to high pressure experiments of additively manufactured layered propellant
- Analyze effects of photopolymers on ammonium perchlorate composite propellant
- Additively manufacture ablative nozzle materials (carbon fiber reinforced silicon carbide)
- Additively manufacture ammonium perchlorate composite propellant (85% solids loading and 6.9 million cP viscosity)
- Fabricate ammonium perchlorate composite propellant with metal additives and characterize performance
- Measure burning rate and conduct particle capturing experiments of propellants in windowed pressure vessels
- Design and build modifications to commercially available FFF printers to equip them for 3D printing custom viscous materials (VAP)
- Peer reviewed papers for *Combustion Science and Technology*, *Journal of Hazardous Materials, AIAA Journal of Propulsion and Power,* and *Journal of Aerospace Technology and Management*
- Manage VAP resources in the lab and mentor 3 students whose research involves VAP and multi-material printing

GRADUATE RESEARCH INTERN – NAWCWD China Lake – May 2019 – August 2019

- Modeled layered ammonium perchlorate composite propellant with RocFire code
- Characterize the melt layer of ammonium perchlorate single crystals in-situ at high pressure

CHARACTERIZATION OF SOLID-LIQUID HYBRID ROCKET FUEL GRAIN– Purdue University – August 2018 – December 2018

- Designed solid fuel matrix capable of storing liquid fuel to create a novel solid-liquid hybrid fuel grain
- Tested absorption of liquid fuel into a solid fuel matrix and temperature dependent qualities of constructed grains
- Successfully burned and analyzed the combustion of ~75 wt.% RP-2/25 wt.% HTPB strands in ambient air and in opposed flow burner
- Paper presented at AIAA Propulsion and Energy Forum (2019)

GRADUATE RESEARCH INTERN – NASA Marshall Space Flight Center – June 2018 – August 2018

- Additively manufactured advanced ceramic composite materials for solid rocket nozzle applications
- Designed experiments to test material properties of additively manufactured ceramic composite parts

MULTI-ELEMENT COMBUSTOR WITH SELF-EXCITED INSTABILITIES IN THE TRANSVERSE DIRECTION– Purdue University – January 2018 – May 2018

- Part of team that designed, built, and tested a 7-element combustor that operated with natural gas/air and displayed self-excited combustion instabilities
- Performed simulations in ANSYS Fluent on conditions upstream the combustor and helped with test stand assembly

SUMMER INTERN LEAD, THRUSTER ENGINEER LEAD - Additive Rocket Corporation – April 2015 – August 2016

- Summer Intern Lead: Lead 2 intern teams (~4 students each) to design an additively manufactured tank and valve for satellites. Used CAD software to make designs and ANSYS for structural and fluid simulations. 3D printed models of preliminary designs for testing. Coordinated design reviews between company founders and interns
- Thruster Engineer Lead: Independently designed a 3D printed monopropellant thruster for satellite applications

SMART INTERN – University of Colorado, Boulder – June 2015 – August 2015

- Independently researched the turbulent combustion of hydrogen and air using DNS data and MATLAB analysis. Calculated the distance between two adjacent particles as a function of time and temperature

CAMP INTERN – University of California, San Diego – June 2014 – August 2014

- Independently researched the autoignition temperatures of dimethyl ether and heptane fuel mixtures using CHEMKIN. Compared the CHEMKIN predictions to experimental results

Teaching Experience

GUEST LECTURER – Purdue University – March 2019

- Volunteered to deliver 3 lectures on rocket propulsion in Professor Karen Marais' AAE 251 Aerospace Systems class in two different sections (~130 and ~30 students each)

UNDERGRADUATE RESEARCH ASSISTANT MENTOR – Purdue University – June 2017 – July 2017 and January 2019 – May 2019

- Mentored an undergraduate research assistant in the summer of 2017 as part of a summer research program. Oversaw their project of characterizing the viscosity of propellant and clay with a Brookfield viscometer. Assisted with paper, poster, and presentation revisions. The student (Daniel Inman) became a graduate research assistant at Zucrow in fall of 2018
- Mentored an undergraduate research assistant on developing python scripts to allow customization of gcode for 3D printing. Assisted with paper, poster, and presentation revisions. The student (Aaron Afriat) became a graduate research assistant in summer of 2019 in my research group. I am currently mentoring him on the development of a dual nozzle 3D printer that can additively manufacture two types of energetic materials (i.e. propellants and reactive filaments)
- Mentoring an undergraduate research assistant tasked with developing a customized 3D printer (VAP) and investigating adhesion between dissimilar materials (i.e. aluminum/polyvinylidene fluoride and composite propellant) that will be 3D printed together

EFFECTIVE COLLEGE TEACHING WORKSHOP – Purdue University – October 2019

- Attended a workshop for 1.5 days hosted by Drs. Richard Felder and Rebecca Brent to learn how to teach classes more effectively

Future Faculty Conferences

NEXTPROF NEXUS – Georgia Tech – October 2019

- Competitively applied and was accepted to this program (~30% acceptance rate). The goal was to prepare graduate students and postdocs from diverse backgrounds to apply for tenure-track positions and to successfully achieve tenure in engineering. Hosted by Georgia Tech, University of California Berkeley, and University of Michigan

RISING STARS IN MECHANICAL ENGINEERING – Stanford University – October 2019

- Competitively applied and was accepted to this program (~50% acceptance rate). The goal was to prepare women graduate students and postdocs to apply for tenure-track positions and to successfully achieve tenure in Mechanical Engineering. Hosted by Stanford University, University of California Berkeley, and MIT

Extracurricular Experience

PRESIDENT, SOCIAL CHAIR – Zucrow Student Association – May 2017 – May 2019

- President: Organized social/professional events and represented the student body of Zucrow (180 students). Helped with ME an AAE department interviews, attended college of engineering meetings, facilitated Zucrow Student Council meetings, and coordinated with human resources and the director of Zucrow Laboratories to improve the work environment
- Social Chair: Promoted communication between research groups at Zucrow by coordinating social events. Created the Zucrow Student Council which allows student representatives from each research group to make suggestions on how to improve the workplace to the director of Zucrow Laboratories

UNDERGRADUATE OUTREACH CHAIR – Black Graduate Student Association – May 2017 – May 2018

- Organized GRAD 101, an event that encourages minority undergraduate students to consider graduate/professional school and prepares them for the application process. Coordinated graduate student and administrative volunteers from different

departments. Developed a workshop on writing personal statements

PRESIDENT, SECRETARY, PROPULSION DEPUTY, PROPULSION ENGINEER – Triton Rocket Club – September 2012 – June 2016

- President: Led the effort to become the first university team to send a rocket to space. Guided project teams to finish goals in a timely and efficient manner while maintaining the safety of all members. Organized club activities and secured funding from corporate sponsors. Hosted a resume workshop that serviced hundreds of students. Began an outreach program to local high schools to increase interest in STEM. Static fired a P motor and launched a rocket with an O-8000 motor
- Secretary: Wrote detailed reports for funding and organized club recruitment activities
- Propulsion Deputy: Led and organized the mixing of ammonium perchlorate composite propellant. Test fired solid rocket engines
- Propulsion Engineer: Worked in a group to build, test, and launch a K-motor rocket fueled by potassium nitrate. Fiberglassed the rocket body, prepared the propellant, and constructed rocket engines

LABVIEW ENGINEER – University of California, San Diego – March 2016 – June 2016

- Worked in a team for a senior design project to successfully test a kerosene emulsion of 9% water in an LR-101 K motor
- Developed LABVIEW code to control a liquid rocket test stand. Programmed it to successfully fire a kerosene rocket motor and acquire thrust, pressure, temperature, and specific impulse data. Included abort safety feature to stop fuel and LOX feeds and vent the stand in the case of an emergency. Analyzed the data. Contributing author on resulting conference paper (JANNAF December, 2016)

SENSORS ENGINEER – Students for the Exploration and Development of Space – August 2014 – April 2015

- Calibrated and tested an Infrared camera to record the temperature of a rocket engine during a static fire test

Volunteer Experience

SESSION MODERATOR – Purdue University – July 2020

- Moderated a virtual SURF conference session for undergraduate researchers who were presenting their summer research projects

MENTOR – Purdue University – February 2018, February 2020

- Participated in Introduce a Girl to Engineering Day. Engaged with middle school to early high school girls to promote their interest in engineering. Mentored students on project based activities and provided advice on pursuing education related to engineering fields

Presentations

CHARACTERIZATION OF THE MELT LAYER OF AMMONIUM PERCHLORATE SINGLE CRYSTALS

- AIAA Joint Propulsion & Energy Conference. August 25, 2020. Oral presentation. Virtual forum. (Paper #: AIAA 2020-3902)

INVESTIGATION OF ADDITIVELY MANUFACTURED COMPOSITE SOLID PROPELLANT

- AIAA SciTech Forum, January 8, 2020. Oral presentation. Orlando, FL. (Paper #: AIAA 2020-1427)

SWEATING HYBRID ROCKET FUELS; INCLUSION AND TEMPERATURE ACTIVATED RELEASE OF LIQUID FUELS IN SOLID BINDERS

- AIAA Joint Propulsion & Energy Conference. August 21, 2019. Oral presentation. Indianapolis, IN. (Paper #: AIAA 2019-4190)

ADDITIVE MANUFACTURING OF COMPOSITE SOLID PROPELLANT INTO COMPLEX GEOMETRIES

- 50th International Annual Conference of the Fraunhofer ICT. June 25-28, 2019. Poster presentation. Karlsruhe, Germany. ***1st prize in poster competition***

ADDITIVE MANUFACTURING OF CARBON FIBER REINFORCED SILICON CARBIDE ROCKET NOZZLES

- AIAA SciTech Forum. January 7, 2019. Oral presentation. San Diego, CA. (Paper #: AIAA 2019-0408)

ADDITIVE MANUFACTURING OF AMMONIUM PERCHLORATE COMPOSITE PROPELLANT WITH HIGH SOLIDS LOADINGS

- 37th International Combustion Symposium. August 3, 2018. Oral presentation. Dublin, Ireland
- 45th International Conference on Metallurgical Coatings and Thin Films. April 25, 2018. Oral presentation. San Diego, CA
- Material Research Society. November 27, 2017. Oral presentation. Boston, MA

LAGRANGIAN COHERENT STRUCTURES OF PREMIXED-TURBULENT REACTING FLAMES

- LSAMP Symposium. February 22-24, 2016. Poster presentation
- Rocky Mountain Fluid Mechanics Symposium. August 4, 2015. Poster Presentation
- Leadership Alliance National Symposium 2015. July 24-26, 2015. Oral presentation

ANALYSIS OF DIMETHYL ETHER/HEPTANE MIXTURES

- Twenty-Eighth Annual UC San Diego Undergraduate Research Conference. April 25, 2015. Oral Presentation. Faculty nomination required for participation
- CAMP Statewide Symposium. February 6-7, 2015. Poster Presentation. Honorable Mention
- UCSD Summer Research Conference. August 14, 2014. Oral Presentation

Publications

1) **M.S. McClain**, M. Ruesch, C. Dennis, S.F. Son, "Characterization and Measurement of the Melt Layer of Ammonium Perchlorate Single Crystals and Pellets at High Pressures", (In preparation for submission to *Combustion and Flame* in August 2020)
2) **M.S. McClain**, A. Afriat, B. Montano, S. Ray, J.F. Rhoads, I.E. Gunduz, S.F. Son, "Experimentation of Layered Ammonium Perchlorate Composite Propellant Fabricated with Vibration Assisted Printing", (In preparation for submission to *AIAA Journal of Propulsion and Power* for submission in August 2020)
3) **M.S. McClain**, B. Bojko, S.F. Son, "Modeling of Layered Ammonium Perchlorate Composite Propellant with Different Burning Rates", (In preparation for submission to *Combustion and Flame* for submission in September 2020)
4) D.N. Collard, **M.S. McClain**, N.H. Dorcy, N.A. Rahman, T.R. Meyer, S.F. Son, "Dynamic X-ray Imaging of Perforation Development and Volume Consumption in Solid Propellants with Additively Manufactured Reactive Components", (Under review at *AIAA Journal of Propulsion and Power* in June 2020)
5) **M.S. McClain**, A. Afriat, J.F. Rhoads, I.E. Gunduz, S.F. Son, "Inside Cover: Development and Characterization of a Photopolymeric Binder for Additively Manufactured Composite Solid Propellant Using Vibration Assisted Printing", *Propellants, Explosives, and Pyrotechnics,* Vol. 45(6), 2020, pp. 846, doi: 10.1002/prep.202080602.
6) **M.S. McClain**, A. Afriat, J.F. Rhoads, I.E. Gunduz, S.F. Son, "Development and Characterization of a Photopolymeric Binder for Additively Manufactured Composite Solid Propellant Using Vibration Assisted Printing", *Propellants, Explosives, and Pyrotechnics,* Vol. 45(6), 2020, pp. 853-863, doi: 10.1002/prep.201900387.
7) **M.S. McClain**, I.E. Gunduz, S.F. Son, "Additive Manufacturing of Ammonium Perchlorate Composite Propellant with High Solids Loadings". *Proceedings of the Combustion Institute,* Vol. 37 (3), 2019, pp. 3135-3142, doi: 10.1016/j.proci.2018.05.052.
8) I.E. Gunduz, **M. McClain**, P. Cattani, G. T.-C. Chiu, J.F. Rhoads, S.F. Son, "3D Printing of Extremely Viscous Materials Using Ultrasonic Vibrations". *Additive Manufacturing,* Vol. 22, 2018, pp. 98-103, doi: 10.1016/j.addma.2018.04.029.

Conference Proceedings

1) **M.S. McClain**, M.D. Ruesch, R.J. Tancin, C. Dennis, C.S. Goldenstein, S.F. Son, "Characterization of the Melt Layer of Ammonium Perchlorate Single Crystals, AIAA Propulsion & Energy Forum, (2020-3902).
2) **M.S. McClain**, A. Afriat, J.F. Rhoads, I.E. Gunduz, S.F. Son, "Investigation of Additively Manufactured Layered Composite Solid Propellant", AIAA SciTech, (2020-1427), doi: 10.2514/6.2020-1427.
3) **M.S. McClain**, M. Paik, C. Farrell, J.P Youngblood, T.L. Pourpoint, "Sweating Hybrid Rocket Fuels; Inclusion and Temperature Activated Release of Liquid Fuels in Solid Binders", AIAA Propulsion & Energy Forum, (2019-4190), doi: 10.2514/6.2019-4190.
4) D. N. Collard, **M.S. McClain**, T.J. Fleck, N.A. Rahman, J.F. Rhoads, T.R. Meyer, S.S. Son, "Solid Propellant with Embedded Additively Manufactured Reactive Components", AIAA Joint Propulsion & Energy Forum, (2019-4443), doi: 10.2514/6.2019-4443.
5) **M.S. McClain**, A. Afriat, J.F. Rhoads, I.E. Gunduz, S.F. Son, "Additive Manufacturing of Composite Solid Propellant into Complex Geometries", 50th International Annual Conference of the Fraunhofer ICT, Conference Proceedings, 2019, Paper #86.
6) D.N. Collard, **M.S. McClain**, T.J. Fleck, N.A. Rahman, J.F. Rhoads, T.R. Meyer, S.F. Son, "Additively Manufactured Solid Propellant and Embedded Reactive Components", 50th International Annual Conference of the Fraunhofer ICT, Conference Proceedings, 2019, Paper #28.
7) **M.S. McClain**, I.E. Gunduz, S.F. Son, "Additive Manufacturing of Carbon Fiber Reinforced Silicon Carbide Solid Rocket Nozzles", AIAA SciTech (2019-0408), doi: 10.2514/6.2019-0408.
8) D. Acosta, A. Batista, R. Bertino, A. Kasses, M. Knight, M. Koizumi, **M. McClain**, N. Montoya, C. Pfeiffer, J. Tang, S. Harrington, "Static Fire Testing of Emulsified RP-1 Utilizing a Bipropellant LR-101 Rocket Engine". JANNAF PIB /11th MSS/9th LPS/8th SPS Joint Subcommittee Meeting. 5–9 December 2016.

Invited Seminars

1) "How to 3D Print a Solid Rocket Motor and Why You Might Want To", **University of Arizona**, Aerospace & Mechanical Engineering department, February 28, 2019.
2) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite Structures", **Penn State University**, Aerospace Engineering department, November 13, 2019.
3) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite

Structures", **Purdue University**, Mechanical Engineering department, January 16, 2020.

4) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite Structures", **Notre Dame University**, Aerospace and Mechanical Engineering department, January 21, 2020.
5) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite Structures", **University of Illinois Urbana Champaign**, Aerospace Engineering department, January 30, 2020.
6) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite Structures", **University of Colorado Boulder**, Aerospace Engineering department, February 14, 2020.
7) "Additive Manufacturing of Viscous Materials: Development and Characterization of 3D Printed Energetic and Composite Structures", **Georgia Institute of Technology**, Aerospace Engineering and Mechanical Engineering departments, March 3, 2020.

Awards

NASA Space Technology Research Fellowship	August 2017 to present
Purdue Doctoral Fellowship	August 2016 to present
GEM Associate Fellow	August 2016 to present
NACME Scholar	January 2016-June 2016
Ellen and Roger Revelle Scholarship	