

Trevor G. Aguirre

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CAREER OBJECTIVE AND PROFILE

I intend to develop the next-generation of additively manufactured ultra-high temperature ceramics and ceramics composites with enhanced thermal, mechanical, and oxidation performance. An understanding of difficult-to-process ceramics is needed to utilize/synthesize these materials using additive manufacturing methodologies.

I am an early career research and development materials engineer with experience in identifying and solving complex problems within the ceramics and additive manufacturing fields. To solve these problems, I leverage an advanced research and academic background combined with experience gained working with industry-leading organizations to conduct applied research and develop procedures and processes to resolve technical challenges. I am driven, a self-starter, and a quick learner with excellent written and verbal communication skills.

EDUCATION

- 2020** **Colorado State University (CSU)** – Fort Collins, Colorado
Doctor of Philosophy: Mech. Engr., Advisor: Dr. Seth W. Donahue, GPA: 3.57/4.00
Dissertation: Bio-inspired Design for Engineering Applications - Empirical and Finite Element Studies of Mechanically Adapted Bone Architectures
- 2017** Master of Science: Mech. Engr., Advisor: Dr. Troy B. Holland, GPA: 3.57/4.00
Thesis: Effects of the addition of boron-nitride nanoplatelets to hydroxyapatite: processing, testing, and characterization
- 2014** Bachelor of Science: Mech. Engr. GPA: 3.17/4.00
- 2010** **Western Nebraska Community College (WNCC)** – Scottsbluff, Nebraska
Associate of Science: Engineering, GPA: 3.19/4.00
Associate of Science: Mathematics, GPA: 3.19/4.00

TECHNICAL PROFILE

- Experimental** Ceramic powder processing, reaction processing (solid-solid reaction, gas-solid reaction, nitriding, carburizing, melt infiltration), densification/sintering, microstructural characterization, processing-microstructure-property relationships of ceramics, mechanical and thermophysical properties of ceramics up to ultra-high temperatures, ultra-high-temperature ceramics (borides, carbides, nitrides), finite-element modeling (porous architectures and environmental barrier coatings), Design of Experiments (DOE)
- Equipment** Debinding ovens, sintering furnaces (vacuum, graphite, SiC, MoSi₂), hot-presses, spark-plasma sintering press, hydraulic compaction presses, Hydraulic and servo-mechanical testing frames, load cells, strain gauges, LVDTs, data acquisition, gas delivery systems, mass flow controllers, vacuum systems, thermocouples, optical pyrometers, binder jet additive manufacturing. Basic proficiency with extrusion, lithography, and electron and laser beam printers.
- Analytical** SEM/EDS/EBSD, powder XRD systems, optical microscopy, TGA, strength (compression, flexural, tension), fracture toughness (indentation, CN, SENB, SEVNB), hardness (Vickers, Knoop), Elastic Moduli (stress-strain response)
- Software** MS Office, Adobe Acrobat, Minitab, MATLAB, LABVIEW, ImageJ, Solidworks, ABAQUS, nTop, OriginPro

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RESEARCH BASED EMPLOYMENT

Current Oak Ridge National Laboratory

Associate Research and Development Staff

Supervisor: Dr. James W. Klett

Feb. 2023-Current

- Continuing development of additive manufacturing (AM) strategies for 1) refractory and ultra-high temperature ceramics and ceramics composites and 2) ceramic-metallic heterogenous material composites
- Continued development of porous reaction-bonded silicon nitride.
- Developed a method for printing of bi-modal silicon-carbide (SiC) powders on binder jet AM with increased strength after SiC chemical vapor infiltration.

Alvin M. Weinberg Distinguished Staff Fellow

Supervisors: Dr. Vlastimil Kunc

Oct. 2020–July 2022,

Dr. James W. Klett

July 2022–Feb. 2023

- Developing additive manufacturing (AM) strategies for 1) refractory and ultra-high temperature ceramics and ceramics composites and 2) ceramic-metallic heterogenous material composites
- Developing novel SiC-SiC-W and SiC-ZrB₂-W composites that were tested for potential use as a thermal protection system on a sounding rocket as part of the Sandia National Labs H4H campaign in October 2021.
- Developed novel method for processing of near-net-shape reaction bonded porous silicon nitride.
- Finite element modeling of environmental barrier coatings (EBC) to determine the effect oxide induced stress on the cracking and delamination of the EBC.

ASTRO Scholar and Additive Manufacturing Intern

Supervisor: Dr. Amy M. Elliott

May 2019–Aug. 2019

- Development, testing, and manufacture of ceramic heat exchangers using binder jet additive manufacturing, polymer infiltration and pyrolysis, and reactive melt infiltration.
- Fabrication, characterization, and testing of ultra-high temperature ceramic composites for high temperature applications.

2020 Colorado State University

Graduate Research Assistant, Ph.D

Advisor: Dr. Seth W. Donahue

Aug. 2017–July 2020

- Studied unique porous bone architectures adapted for extreme loading conditions.
- Collected trabecular bone cores from dinosaur tibiae and femora to study bone adaptation.
- Studied and bio mimicked the velar architecture in Rocky Mountain bighorn sheep to generate novel energy absorbing structures for low velocity impact applications (helmets/shoes/vehicles)
- Mechanical testing and finite element analysis of unique trabecular bone architectures to determine structure-based strength differences.

Graduate Research Assistant, M.S.

Dr. Troy B. Holland

Aug. 2014–May 2017

- Statistical experimental design to determine optimal parameters for sintering experiments.
- Designed and manufactured specialty tooling and mechanical testing fixtures.
- Mechanical testing (micro- and nano-hardness, fracture toughness, and flexural strength)

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2014 EVRAZ Rocky Mountain Steel Mill

Product Technology Intern,

Supervisor: Mr. Greg Garcia

May 2014–Aug. 2014

- Developed contact mechanics models to visualize subsurface stress distribution during wheel and rail contact to better understand rolling contact fatigue.
- Developed a graphical tool for tracking metallurgical defect occurrences in rail.
- Tensile testing and data analysis for mechanical property quantification of novel steel alloys
- Gained experience in non-destructive testing processes.

2013 Transportation Technology Center (now MxV Rail)

Engineering Services Intern

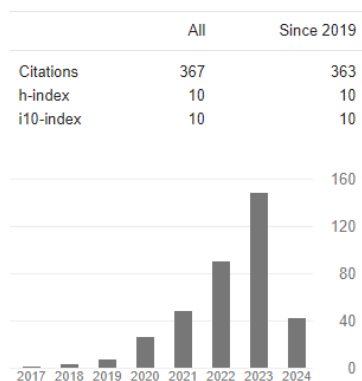
Supervisor: Mr. Greg Garcia

May 2011–May 2013

- Metallographic sample preparation for grain size analysis and non-destructive analyses.
- Gained experience in non-destructive testing processes such as ultrasonic, dye penetrant, and magnetic particle testing to determine flaw size and location in rails.
- Analyzed experimental data to create a wear-growth curve for trafficked railroad track.

IMPACT (Updated March 13th, 2024)

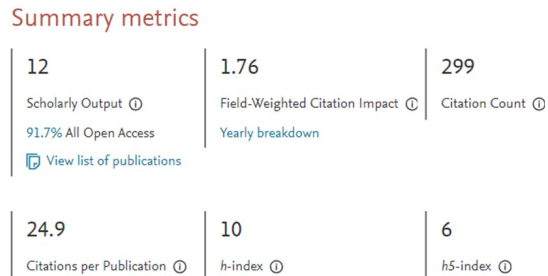
Google Scholar



ResearchGate



SciVal



PROGRAMS

1. Synthesis of monophosphides for extreme environments. DOE, ORNL SEE, LOIS ID: 11645. Role: Principal Investigator.
2. Additive manufacturing of ceramics for harsh environments. DOE, ORNL LDRD, LOIS ID: 10572. Role: Principal Investigator.
3. Additive Manufacturing of High Resolution SiC Fiber Composite Components for Utilization in Energy Systems. DOE, Office of Energy Efficiency & Renewable Energy. Program Manager Stephen Sikirica, Project No. DE-EE0010216.0000. Collaboration between GE Additive, GE Energy, & ORNL. Role: Principal Investigator at ORNL
4. Next Generation Environmental Barrier Coatings, DOE, Office of Fossil Energy and Carbon Management, Program Managers Richard Dennis and Rin Burke, Work Proposal #: FEAA149. Role: Supporting researcher

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5. Materials and Manufacturing Research for Future Air Force Assets Operating in Extreme Environments, Air Force Research Laboratory, DOE Project No. 2243-Z423-21, Role: Supporting Researcher

AWARDED FUNDING

1. \$500,000 – Additive manufacturing of ceramics for harsh environments – LDRD LOIS ID 10572
2. \$240,000 – Synthesis of monophosphides for extreme environments – SEED LOIS ID 11645
3. \$1,500,00 – Advancement of Kairos Demonstration Pathway of DE-FOA-0002271 – CRADA with Kairos Power and ORNL

REFEREED PUBLICATIONS (Reverse Chronological Order)

1. **T.G. Aguirre**, S. Kim, “Finite element investigation of impact force minimization using lattices”, *In preparation*.
2. **T.G. Aguirre**, C.L. Cramer, B. Groth, E. Cakmak, D. J. Mitchell, V. Kunc, J.W. Klett, “Strength and thermal shock resistance of porous reaction-bonded silicon nitride by direct nitriding of binder jet additively manufactured silicon”, *In preparation*.
3. L. Lin, **T.G. Aguirre**, M.J. Ridley, B.A. Pint, “Collaborating Volume Contraction in Phase Change with User Subroutine Development in Abaqus”, *Submitted*
4. **T.G. Aguirre**, L. Lin, M.J. Ridley, K.A. Kane, B.A. Pint, “Finite element modeling of the phase change in thermally grown SiO₂ in SiC systems for gas turbines”, *Accepted-not yet published*.
5. M.J. Ridley, M.J. Lance, T.G. Aguirre, C.L. Cramer, “Oxidation Performance and Limitations of Additively Manufactured SiC/Si-O-C Composites at Elevated Temperatures”, Online: <https://doi.org/10.1111/jace.19466>
6. C.L. Cramer, E. Ionescu, M. Graczyk-Zajac, A.T. Nelson, Y. Katoh, J.J. Haslam, L. Wondraczek, **T.G. Aguirre**, S. LeBlanc, H. Wang, M. Masoudi, E. Tegeler, R. Riedel, P. Colombo, M. Minary-Jolandan, “Additive Manufacturing of Ceramic Materials for Energy Applications: Road Map and Opportunities”, Online: <https://doi.org/10.1016/j.jeurceramsoc.2022.01.058>
7. **T.G. Aguirre**, B. Lamm, C.L. Cramer, D.J. Mitchell, “Zirconium-diboride silicon-carbide composites: A review”, Online: <https://doi.org/10.1016/j.ceramint.2021.11.314>
8. **T.G. Aguirre**, C.L. Cramer, D.J. Mitchell, “Review of additive manufacturing and densification techniques for the net- and near net-shaping of geometrically complex silicon nitride components”, Online: <https://doi.org/10.1016/j.jeurceramsoc.2021.11.001>
9. **T.G. Aguirre**, C.L. Cramer, E. Cakmak, R.A. Lowden, “Reaction bonded ZrB₂-SiC Composites: In situ formation and mechanical properties”, Online: <https://doi.org/10.1016/j.rinma.2021.100217>
10. A. Ingrole, **T.G. Aguirre**, L. Fuller, S.W. Donahue, “Bioinspired energy absorbing material designs using additive manufacturing”, Online: <https://doi.org/10.1016/j.jmbbm.2021.104518>
11. **T.G. Aguirre**, L. Fuller, A. Ingrole, T.W. Seek, B.D. Steineman, B.B. Wheatley, T.L. Haut-Donahue, S.W. Donahue, “Bioinspired material architectures from bighorn sheep horncore velar bone for impact loading applications”, Online: <https://doi.org/10.1038/s41598-020-76021-5>
12. **T.G. Aguirre**, A. Ingrole, L. Fuller, T.W. Seek, A.R. Fiorillo, J.J.W. Sertich, S.W. Donahue, “Differing trabecular bone architecture in dinosaurs and mammals contribute to stiffness and limits on bone strain”, Online: <https://doi.org/10.1371/journal.pone.0237042>
13. C.L. Cramer, **T.G. Aguirre**, N.R. Wieber, R.A. Lowden, A. Trofimov, H. Wang, J. Yan, M.P. Paranthaman, A.M. Elliot, “Binder jet printed WC infiltrated with pre-made melt of WC and Co,” Online: <https://doi.org/10.1016/j.ijrmhm.2019.105137>

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14. C.L. Cramer, N.R. Wieber, **T.G. Aguirre**, R.A. Lowden, A.M. Elliot, "Shape retention and infiltration height in complex WC-Co parts made via binder jet of WC with subsequent Co melt infiltration," Online: <https://doi.org/10.1016/j.addma.2019.100828>
15. **T.G. Aguirre**, C.L. Cramer, V.P. Torres, T.J. Hammann, T.B. Holland, K.Ma, "Effects on the Mechanical Properties and Weibull Distribution of Boron Nitride Nanoplate Reinforced Hydroxyapatite Composites Prepared by Spark Plasma Sintering," Online: <https://doi.org/10.1016/j.jmbbm.2019.01.021>
16. T.J. Hensen, **T.G. Aguirre**, C.L. Cramer, A.S. Wand, K. Ma, D. Prawel, J.D. Williams, T.B. Holland, "Additive Manufacturing of Ceramic Nanopowder by Direct Coagulation Printing," Online: <https://doi.org/10.1016/j.addma.2018.07.010>
17. C.L. Cramer, **T.G. Aguirre**, K. Ma, T.B. Holland, "Prediction of Porosity Gradients in Ceramics using ZnO as a model material," Online: <https://doi.org/10.1111/jace.15872>

PRESENTATIONS (Reverse Chronological Order)

1. Additively manufactured reaction bonded porous silicon nitride. National Defense Industrial Association Pacific Operational Science & Technology Annual Conference, Honolulu, Hawaii, USA, March 2024, **T.G. Aguirre**, C.L. Cramer, D.J. Mitchell, V. Kunc, J. Klett.
2. *Finite element modeling of the phase change in thermally grown SiO₂ in SiC*. National Defense Industrial Association Pacific Operational Science & Technology Annual Conference, Honolulu, Hawaii, USA, March 2024, **T.G. Aguirre**, L. Lin, M.J. Ridley, K.A. Kane, B.A. Pint.
3. Additively manufactured reaction bonded porous silicon nitride. Composites, Materials, and Structures, St. Augustine Florida, USA, January 2024, **T.G. Aguirre**, C.L. Cramer, D.J. Mitchell, V. Kunc, J. Klett.
4. *Finite element modeling of the phase change in thermally grown SiO₂ in SiC*. Composites, Materials, and Structures, St. Augustine Florida, USA, January 2024, **T.G. Aguirre**, L. Lin, M.J. Ridley, K.A. Kane, B.A. Pint.
5. *Additive Manufacturing Enabling W-SiC and W-ZrB₂-SiC Heterogeneous Materials*. Ultra-High Temperature Ceramics: Materials For Extreme Environment Applications V, Snowbird Utah, USA, June 2022, D. Mitchell, **T. Aguirre (Presenter)**, C. Cramer, A. Schumacher, M. Kirka, C. Ledford, V. Kunc
6. *Cyclic Steam Oxidation of Environmental Barrier Coatings Deposited without a Silicon Bond Coat*. 48th International Conference on Metallurgical Coatings and Thin Films. May 2022. San Diego, CA. M. Ridley (Presenter), K. Kane, C. Parker, M. Lance, **T. Aguirre**, E. Garcia, B. Pint.
7. *Raman Spectroscopic Characterization of Yttrium/Ytterbium Silicates and Thermally-Grown SiO₂ Phases in Environmental Barrier Coatings*. 48th International Conference on Metallurgical Coatings and Thin Films. May 2022. San Diego, California, USA. M.J. Lance (Presenter), M.J. Ridley, K.A. Kane, **T.G. Aguirre**, and B.A. Pint.
8. *Processing of polymer-derived ceramics (PDCs) for fibers, monoliths, and ceramics matrix composites (CMCs)*. 14th Pacific Rim Conference on Ceramic and Glass Technology (PACRIM 14), Vancouver, British Columbia, CA, December 2021, C.L. Cramer (Presenter), S. Bullock, **T. Aguirre**, D. Mitchell, V. Kunc
9. *Additive Manufacturing of Silicon Nitride Using a Slurry Approach*. Materials Science & Technology Technical Meeting & Exposition Columbus Ohio, USA, October 2021. B.L. Armstrong (Presenter), C.L. Cramer, B. Lamm, **T.G. Aguirre**, and D.J. Mitchell
10. *Fabrication and shaping of ZrB₂-SiC composites by reaction bonding with various precursors and consolidation techniques*. International Conference and Expo on Advanced Ceramics and

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Composites, Daytona Beach, Florida January 2020, **T.G. Aguirre**, C.L. Cramer (Presenter), R.A. Lowden, E. Eyeran.

11. *The effect of the addition of white graphene to hydroxyapatite: Processing, Testing, and Characterization*. International Conference and Expo on Advanced Ceramics and Composites, Daytona Beach, Florida, USA January 2017, **T. G. Aguirre (Presenter)**, T.B. Holland.

MEDIA RELEASES (Reverse Chronological Order)

1. Cable News Network (CNN), August 19th, 2020.
<https://www.cnn.com/2020/08/19/world/dinosaur-bones-study-scen/index.html>
2. University of Wyoming, Laramie, WY, March 27th, 2019.
<https://www.facebook.com/uwgeologyandgeophysics/videos/378267269433887/>
3. Wyoming Dinosaur Center, Thermopolis, WY, March 1st, 2019.
<https://www.facebook.com/WyomingDinosaurCenter/videos/2052931628161428/>
4. Washakie Museum and Cultural Center, Worland WY, March 1st, 2019
<https://www.facebook.com/washakiemuseum/videos/1998197320474263/>

PATENTS

1. Mobile stone/bone coring device (US Utility Patent Expired)
<https://csuventures.org/project/precise-coring-methods-and-device-for-bone-and-stone/>
2. Additively Manufactured Refractory Metal-Ceramic Matrix Composites (Patent to be filed). ORNL Patent Record ID: 81934755
3. Preceramic Polymer Printing Binders for Additive Manufacturing of Advanced Ceramics (Patent to be filed). ORNL Patent Record ID: 81937548
4. Manufacture of silicon nitride foams (Patent to be filed). ORNL Patent Record ID: 81933764

AWARDS AND HONORS

- Distinguished Staff Fellow, Oak Ridge National Laboratory, 2020-2023
- ASTRO Program Scholar, Oak Ridge National Laboratory, Summer 2019
- Bob and Bonnie Walker Scholarship Recipient, CSU, 2012-2014
- Scholarships for Information Technology and Engineering Recipient, WNCC, 2008–2010

VOLUNTEERING AND OUTREACH

Current Journal article reviewer

- Reviewed articles for Applied Materials, Results in Materials, International Journal of Refractory and Hard Materials, Advances in Applied Ceramics, Ceramics International,

Current Oak Ridge Chapter of ASM International, Secretary

- Elected to Secretary position in final ASM International meeting in Spring 2023.
- Official duties include note taking and event planning/coordination.

2019 Multicultural Undergraduate Research, Arts, and Leadership Symposium May 2015–May 2019

- Helped develop the MURALS program by making changes to how graduate students were recruited, how presentations were evaluated, and helped undergraduate students develop research and presentation skills.
- Served as mentor to help evaluate undergraduates' abstracts, posters, and oral presentations.

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- Served as lead graduate student. Coordinated 60+ graduate students across the university to evaluate undergraduate abstracts and provide feedback on student presentations.

2018 CSU – Society of Hispanic Professional Engineers (SHPE) *Jan. 2011–May 2018*

- Served as Treasurer, Vice-President, President, and Recruitment and Retention Chair
- Developed new practices/policies to maintain and improve student involvement and retention.

2018 National Graduate Representative – SHPE National *July 2017–July 2018*

- Remotely managed two different teams of seven members across the US to develop and implement programs to increase graduate student value from SHPE involvement.
- Helped develop and plan graduate workshops at the SHPE National Conference

2018 EnPower Mentor *Aug. 2016–Aug. 2018*

- Volunteered to help pilot a mentoring program designed to increase the success and retention of Native American and Hispanic engineering students in the CSU College of Engineering
- Helped students find the resources they needed for success in school, mental/medical health, and volunteering opportunities.

2017 Regional Graduate Representative – SHPE National *July 2016–July 2017*

- Managed Graduate Ambassadors at 15+ universities to promote graduate school awareness and success to Hispanic graduate and undergraduate students.
- Helped develop and plan graduate workshops at the SHPE National Conference

2017 Academic Research Collaboration Mentor *Aug. 2015–May 2017*

- Mentored 10+ SHPE undergraduates in the Advanced Materials Processing and Testing Lab through hands-on training and application of classroom concepts in a lab environment
- Helped students develop analytical and safety skills needed for working in a lab environment.

TEACHING AND EDUCATION EXPERIENCE

CSU - MECH331: Intro. to Materials Science – Graduate Teaching Asst. *Summer 2020*
CSU - MECH307: Mechatronics and Measurement Systems – Graduate Teaching Asst. *Spring 2020*
CSU - MECH331: Intro. to Materials Science – Graduate Teaching Asst. *Fall 2019*
CSU - MECH201: Engineering Design I – Graduate Teaching Fellow *AY 2018–19*
CSU - MECH231: Engineering Experimentation – Graduate Teaching Asst. *2014–2017*
WNCC - Mathematics and Physics Tutor *Spring 2009 – Fall 2010*

REFERENCES

Dr. James W. Klett

Group Leader: Extreme Environment Materials Processing Group and R&D Staff, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN

Email: klettjw@ornl.gov

Dr. Vlastimil Kunc

Section Head: Composites Science Technology and R&D Staff, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN

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Dr. Amy M. Elliot

Group Leader: Robotics & Intelligent Systems and R&D Staff, ORNL, Oak Ridge, TN

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Dr. Corson L. Cramer

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Mr. Thomas R. Muth

Senior R&D Staff, ORNL, Oak Ridge, TN

Email: muthtr@ornl.gov

Dr. Seth W. Donahue

Professor, Department of Biomedical Engineering, University of Massachusetts Amherst

Email: swdonahue@umass.edu

Mr. Greg Garcia

NDT Level III Engineer, Program Coordinator, EVRAZ Rocky Mountain Steel Mill, Pueblo, CO

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