CURRICULUM VITAE

**Jerome P. Downey, Ph.D., P.E.**

**EDUCATION**

Ph.D. Metallurgical and Materials Engineering, Colorado School of Mines, 1991

Thesis: Pyrohydrolytic De-halogenation of Electric Arc Furnace Dusts

M.S. Metallurgical Engineering, Montana Tech, 1982

Thesis: Elemental Distribution of Lime-Roasted Flue Dusts in a Copper Matte-Slag System

B.S. Metallurgical Engineering, Montana Tech, 1977

**ACADEMIC EXPERIENCE**

2019-Present Dept. Head, Metallurgical and Materials Engineering, Montana Tech

2015-Present Professor (tenured), Metallurgical and Materials Engineering, Montana Tech

2013-Present Campus Director, Materials Science and Engineering Graduate Program

2009-2015 Associate Professor, Metallurgical and Materials Engineering, Montana Tech

2006-2009 Assistant Professor, Metallurgical and Materials Engineering, Montana Tech

**INSTRUCTION – COURSES TAUGHT, Spring 2006 through Spring 2022**

EMET 194 Freshman Seminar S2007-08

EGEN 213 Intro to Metallurgical and Materials Engineering S2006, F2006-10

EMET 307 Metallurgical and Materials Thermodynamics S2006-16, 18-23

EMET 402 Pyrometallurgy and Thermal Processing F2006-13, 16, 21

EMET 405 Extractive Metallurgy Laboratory F2011-14\*, 18

M&ME 423/523 Multicomponent Phase Diagrams S2008, 10

EMAT 441 Metallurgical & Materials Flow Sheet Design S2009

EMAT 451 Process Instrumentation and Control S2006-13

EMAT 471 Materials Analysis and Characterization S2007

EMET 489 Senior Design I F2006, 08, 11-17

EMET 499W Senior Design II S2007, 09, 12-18

EMET 494W Senior Seminar F2007, 16-17, 19

EMET 420/520 Physical Chemistry of Iron and Steelmaking F2008-10,13; S2012-13, S23

EMAT 523 Advanced Thermodynamics F2011, 13-22

EMET 595 Special Topics/Recycling of Metals and Materials F2006, 08

EMET 595 Special Topics/Process Development F2007

EMET 595 Special Topics/Advanced Thermodynamics S2009

EMET 595 Special Topics/Advanced Pyro-processing F2009-10, 12, 17, 19

EMAT 597/530\* Energy Issues and Analysis S2010-14, 16

MTSI 500 Materials Science & Engineering Seminar F&S2014-20, F22

MTSI 502 Adv. Materials Science II – Function & Application S2018\*

MTSI 511 Thermodynamics of Materials F2014-22

\*co-instructor

**GRADUATE RESEARCH ACTIVITIES**

**STUDENT RESEARCH-RELATED PUBLICATIONS**

**Chorney MP**, Downey JP, Sudhakar KV (2023) Development of an Experimentally Derived Model for Molybdenum Carbide (Mo2C) Synthesis in a Fluidized-Bed Reactor. In: Advances in Powder and Ceramic Materials Science. Springer, Cham, pp 17–25.

**Teagan J. Leitzke**, J. Downey, Richard M. LaDouceur, Daisy M. Margrave, Grant C. Wallace, and David L. Hutchins, Water Treatment Method for Removal of Select Heavy Metals and Nutrient Ions through Adsorption by Magnetite, ACS ES&T Water, 2022, https://doi.org/10.1021/acsestwater.2c00242.

**Maureen P. Chorney,** Kunal Mondal, Jerome P. Downey and Prabhat K. Tripathy, “On the Sintering Behavior of Nb2O5 and Ta2O5 Mixed Oxide Powders, *Materials* 2022, 15, 5036. https://doi.org/10.3390/ma15145036

**Jannette Chorney,** Jerome Downey, K.V. Sudhakar, Morgan Ashbaugh, and Grant Wallace, Thermal Analysis of Potential High Entropy Alloy Binder Alternatives for Tungsten Carbide, The 12th International Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Society, TMS Springer 2022, 175-183.

**Maureen P. Chorney**, Jerome P. Downey, and K.V. Sudhakar, Evaluation of Processing Parameters for the Production of Tungsten Carbide in a Fluidized Bed Reactor, The 12th International Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Society, TMS Springer 2022, 393-401.

**Felix Davis** and Jerome Downey, “Liberation and Separation of Ultrafine Tungsten Carbide Particles from an Activated Carbon Substrate,” ACS Sustainable Chemistry & Engineering, https://doi.org/10.1021/acssuschemeng.1c07261.

**Maureen P. Chorney**,Bridger P. Hurley, Kenal Mondal, Amey Khanolkar, Jerry Downey, Prabhat K. Tripathy, “Transformation of a Ceramic Precursor to a Biomedical (Metallic) Alloy: Part I Sinterability of Ta2O5 and TiO2 Mixed Oxides,” Materials Science for Energy Technologies (5), 2022, 181-188.

**Grant Wallace**, Jerome Downey, Jannette Chorney, and Katie Schumacher, “Optimization of the Process Parameters for the Synthesis of Mo2C on an Activated Carbon Matrix,” The 11th International Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Series, TMS Springer, 2020, 715-724. Also presented at the 2020 TMS Annual Meeting in San Diego, CA.

**Teagan Leitzke**, Jerome Downey, David Hutchins, and Brian St. Clair, “Continuous Flow Process for Removal and Recovery of Water Contaminants with Magnetic Composites,” Nanocomposites VI: Nanoscience and Nanotechnology in Advanced Composites – Polymer and Other Nanocomposites, The Minerals, Metals, and Materials Series, TMS Springer, 2019, 155-164. Also presented at the 2020 TMS Annual Meeting in San Diego, CA.

**Trenin Bayless**, Jerome Downey, Peter Lucon, and Scott Coguill, “Computational Polyethylene-Ceramic Composite Plate Design and Optimization,” TMS 2020 149th Annual Meeting & Exhibition Supplemental Proceedings, The Minerals, Metals, and Materials Series, TMS Springer, 2020, 1489-1498. Also presented at the 2020 TMS Annual Meeting in San Diego, CA.

**STUDENT RESEARCH-RELATED PUBLICATIONS, continued**

**David L. Hutchins** and Jerome P. Downey (2019) Effective separation of magnetite nanoparticles within an industrial-scale pipeline reactor, Separation Science and Technology, DOI: [10.1080/01496395.2019.1646762](https://doi.org/10.1080/01496395.2019.1646762)

**Grant Wallace,** Jerome Downey, et al,Statistical Optimization of Tungsten Carbide Synthesis Parameters, *10th International Symposium on High-Temperature Metallurgical Processing*, The Minerals, Metals, and Materials Series, TMS, 2019, 371-378. Presented at the 2019 TMS Annual Mtg. in San Antonio, TX.

**Trenin K. Bayless**, Jerome P. Downey, Grant C. Wallace and Marc D’Aberle, Density Separation of Mixed Carbide Colloids via Standing Wave Physics, TMS 2019 148th Annual Meeting Supplemental Proceedings, TMS, 2019, 1521-1532. Presented at the 2019 TMS Annual Mtg. in San Antonio, TX.

**Grant Wallace,** Jerome Downey, et al,Synthesis of Nanocrystalline Carbide Ceramics via Reduction of Anion-Loaded Activated Carbon Precursors, 9*th International Symposium on High-Temperature Metallurgical Processing*, The Minerals, Metals, and Materials Series, TMS, 2018, 125-134. Presented at the 2018 TMS Annual Mtg. in Phoenix, AZ.

**Grant Wallace,** Jerome Downey, et al,Synthesis of Carbide Ceramics from Activated Carbon Precursors loaded with Tungstate, Molybdate, and Silicate Anions, *Advances in Ceramics for Environmental, Functional, Structural, and Energy Applications*, Ceramic Transactions Vol. 265, The American Ceramics Society, John Wiley & Sons, 2018, 137-149. Presented at MS&T 17, Pittsburgh, PA, Oct. 2017.

**Maureen Chorney**, Bridger Hurley, Prabhat Tripathy, and Jerome Downey, Effects of Oxide Precursor Preparation on the Electrochemical Reduction of Tantalum Pentoxide in Calcium Chloride Melt, *The Minerals Metals and Materials Society, TMS 2017 146th Annual Meeting & Exhibition Supplemental Proceedings*, 2017, 651-655. Presented at 2017 TMS Annual Meeting, San Diego, CA.

**Katelyn Lyons**, Jerome Downey, Jannette Chorney, and Katie Schumacher, Selective Separation of Rare Earth Chlorides utilizing Vapor Phase Extraction, *Rare Metal Technology 2017*, The Minerals, Metals, and Materials Society Series, TMS, 2017, 55-63. Presented at 2017 TMS Annual Meeting, San Diego, CA.

**Grant Wallace**, Jerome Downey, Jannette Chorney, and Alaina Mallard, and David Hutchins, Synthesis of Carbide Ceramics via Reduction of Adsorbed Anions on an Activated Carbon Matrix, *8th International Symposium on High-Temperature Metallurgical Processing*, The Minerals, Metals, and Materials Series, TMS, 2017, 49-57. Presented at 2017 TMS Annual Mtg. in San Diego, CA.

**Ryan Foy**, Steve Lloyd, Brandon Steinborn, and Jerome Downey, “Sulfation Roasting of a Bornite Flotation Concentrate to Optimize Silver Extraction in a Ferric Chloride Leach,” Drying, Roasting, and Calcining of Minerals, The Minerals, Metals, & Materials Society (TMS), 2015, 3-10. Presented at 2015 TMS Annual Meeting in Orlando, FL.

**Bryce Ruffier**, Daniel Gaede, Jerome Downey, Larry Twidwell, Jannette Chorney, Ryan Foy, and Katelyn Lyons, “Bromination of Rare Earth Element Oxides,” Drying, Roasting, and Calcining of Minerals, TMS, 2015, 19-26. Presented at 2015 TMS Annual Meeting in Orlando, FL.

**Daniel Gaede**, Bryce Ruffier, Jerome Downey, Larry Twidwell, Jannette Chorney, Ryan Foy, and Katelyn Lyons, “Chlorination of Rare Earth Element Oxides,” Drying, Roasting, and Calcining of Minerals, TMS, 2015 11-18. Presented at 2015 TMS Annual Meeting in Orlando, FL.

**STUDENT RESEARCH-RELATED PUBLICATIONS, continued**

**Teresa D.H. McGrath,** Jesse White, and Jerome Downey, “Experimental Determination of Density in Molten Lime Silicate Slags as a Function of Temperature and Composition,” Mineral Processing and Extractive Metallurgy (TIMM C), Volume 123, 178-183, Number 3, September 2014.

**Katie J. Schumacher**, Jesse White, and Jerome Downey, “Viscosities in the Calcium Silicate Slag System in the Range of 1798 to 1973K (1525 to 1700°C),” Metallurgical Transactions B, Volume 46B, Number 1, February 2015, 119-124.

**Tyler Salisbury**, Jerome Downey, et al, “Free Form Fabrication of Catalytic Substrates,” Energy Technologies 2012: Materials in Clean Power Systems VII: Clean Coal, Hydrogen-Based Technologies, and Fuel Cells, TMS, 2012, 323-330. Presented at 2012 TMS Annual Mtg., Orlando, FL.

**Stacy Davis**, Jerome Downey, et al, “Improved Palladium Coatings for Hydrogen Purification Applications,” Energy 2012: Materials in Clean Power Systems VII: Clean Coal, Hydrogen-Based Technologies, and Fuel Cells, TMS, 2012, 331-338. Presented at 2012 TMS Annual Mtg., Orlando, FL.

Jerome P. Downey, Arijit Bose, Guy Fredrickson, and **Ashish** **Jha**, A Magnetic-Field Reactor for Metal Removal from Dilute Wastewater Streams, Hydrometallurgy 2008 – Proceedings of the Sixth International Symposium, Society for Mining, Metallurgy, and Exploration, 2008, 162-168. Presented at Robert S. Shoemaker International Symposium on Hydrometallurgy, Phoenix, AZ.

**Ashish Jha**, Arijit Bose, and Jerome Downey, Removal of As(V) and Cr(VI) Ions from Aqueous Solution using a Continuous Hybrid Field Gradient Magnetic Separation Device, Separation Science and Technology, 2006, Volume 41, Number 15, 3297-3312.

**DISSERTATION/THESIS ADVISOR – GRADUATE STUDENT COMPLETIONS**

**Morgan Ashbaugh**, **M.S.,** Materials Science and Engineering; *Microstructural Analysis of High Entropy Alloys for Cemented Carbide Applications,* 2023.

**Teagan Leitzke,** **Ph.D.,** Materials Science, *Capture of Metals and Nutrients from Natural Waters with Magnetic Nanocomposite Materials in a Continuous Flow Material Recovery System*; 2022.

**Trenin Bayless, Ph.D.,** Materials Science; *Inhomogeneous Composite Design for High Energy Impact Resistance through Computational Design, Physical Testing and Analysis, and Mathematical Modeling*; 2021.

**Auva Speiser, M.S.**, Materials Science & Engineering; non-thesis practicum *Silicon Carbide Synthesis via Anion-Loaded Activated Carbon*, 2021.

**Grant Wallace**, **Ph.D.**, Materials Science; *Synthesis of Carbide Ceramics via Reduction and Carburization of Oxyanions Adsorbed onto an Activated Carbon Matrix*; 2020.

**David Hutchins**, **Ph.D.**, Materials Science; *Recovery of Metal Contaminants from Industrial Wastewaters with Magnetic Nanocomposites in a Novel Continuous Flow Process System*; 2018.

**Maureen Chorney,** **M.S.,** Metallurgical and Mineral Processing Engineering, *Investigation of Solid-State Sintering Behavior of Binary Refractory Metal Oxide Systems*, 2018.

**Katelyn Lyons, M.S.**, Metallurgical and Mineral Processing Engineering, *Technical Feasibility of Separating Rare Earth Elements by Vapor Phase Extraction and Condensation*, 2017.

**Dan Gaede**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Chlorination and Selective Vaporization of Rare Earth Elements*, 2016.

**Ryan Foy**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Characterization and Extraction Optimization for Silver-Containing Bornite Flotation Concentrate Investigation of Methods to Enhance Copper, Silver, and Lead Extraction from Troy Mine, Ltd. Flotation Concentrate*, 2014.

**Ashley Carter, M.S.**, Metallurgical and Mineral Processing Engineering, *Chlorination and Vapor Phase Extraction of Rare Earth Element Concentrate from the Bear Lodge Property, Wyoming*, 2013.

**DISSERTATION/THESIS ADVISOR – GRADUATE STUDENT COMPLETIONS, continued**

**Diane Bell**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Vapor Phase Removal of Rare Earth Oxides for the Use with Spent LWR Fuel Recycling*, 2012.

**Stacy (Davis) Torrey**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Electroless Plating of Palladium on Stainless Steel Substrates in Hydrazine Solutions: A Study of the Relationships between Bath Parameters, Deposition Mechanisms, and Deposit Morphologies*, 2011.

**Sean Dudley**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Evaluation of Fly-Ash-Based Artificial Zeolite Formation as a Treatment for Salt-Laden Process Water from Eastern Montana Coal Operations*, 2011.

**Tyler Salisbury**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Fabrication and Characterization of Porous 420 Stainless Steel Substrates Produced using Rapid Prototyping Technology and Thermally Strengthened using Solid State Sintering*, 2011.

**Teresa McGrath**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Density Measurements in High Temperature Ionic Melts*, 2010.

**Jeffrey Kline**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Critical Evaluation of the Experimental Methods for Determining Chemical Diffusivity of Impurity Species in Ionic Melts*, 2009.

**Katie Schumacher**, **M.S.**, Metallurgical and Mineral Processing Engineering, *Correlations between Optical Basicity and Viscosity in the Calcium Silicate System*, 2009.

**DISSERTATION/THESIS ADVISOR – IN PROGRESS**

**Katie Schumacher,** Materials Science Ph.D. Candidate; *Synthesis and Applications of Polymer Cross-linked Aerogels* (working title); funded ARL; *in progress*.

**Alexander George,** Materials Science Ph.D.Candidate; *Thermodynamic Properties and Development of Improved Metallic Glass* *Processing Methods* (working title); funded by ARL; *in progress*.

**Daisy Margrave**, M.S. student in Materials Science and Engineering; *Physical Separation of Ultra-fine Carbide Particles from a Graphite Substrate* (working title); partially funded by ARL; *in progress*.

**Trevor Russell**, M.S. student in Materials Science and Engineering; *Metal Ion Desorption and Regeneration of Magnetite Nanoparticles in a Continuous Flow Metal Recovery System* (working title); funded by NSF EPSCoR CREWS; *in progress*.

**Taylor Christensen**, M.S. student in Materials Science and Engineering; *Synthesis of Silicon Carbide via the Adsorption-Reduction-Carburization-Separation (ARCS) Process* (working title); funded by ARL; *in progress*.

**Alisa Hashley**, M.S. student in Materials Science and Engineering*; Evaluation and Optimization of Natural and Synthetic Magnetite Nanoparticles for Ion Adsorption* (working title); funded by NSF EPSCoR CREWS; *in progress.*

**Daniel Goettlich**, M.S. student in Materials Science and Engineering; *Recovery of Scandium and Select Rare Earth Elements via the Continuous Flow Metal Recovery System* (working title); funded by NSF EPSCoR CREWS; *in progress*.

**Emma Carvo**, M.S. student in Materials Science and Engineering; *Development of a low carbon technology for metal recovery from waste metallurgical slags* (working title): funded by DOE EPSCoR*; in progress*.

**PRINCIPAL INVESTIGATOR & COMMITTEE MEMBER – IN PROGRESS:**

**Jan Chorney,** Materials Science Ph.D.Candidate; *Evaluation of High Entropy Alloys as Potential Non-Toxic Binders for Cemented Carbide Applications* (working title); funded by ARL; *in progress*.

**Maureen Chorney,** Materials Science Ph.D. Candidate, *Synthesis of Non-oxide Ceramic Materials in a Fluidized-Bed Reactor* (working title); funded by ARL; *in progress*.

**GRADUATE STUDENT RESEARCH COMMITTEE MEMBER**

**In progress:**

David Rathgeber, Ph.D. Candidate, Materials Science (MTU)

Isabelle Gordon, Ph.D. Candidate, Materials Science (MSU)

Travis van Leeuwin, Ph.D. Candidate, Materials Science (MSU)

Pierce Fix, Ph.D. student, Materials Science (MSU)

Amirhosein Riahi, Ph.D. Candidate, Earth Science & Engineering (MTU)

**Completions:**

Josh Sinrud, Ph.D. Materials Science (MSU), 2022

Marshall McNally, Ph.D. Materials Science (MSU), 2022

Julie Muretta, Ph.D. Materials Science (MTU), 2022

Stephen Heywood, Ph.D. Materials Science (MSU), 2022

Molly Brockway, Ph.D. Materials Science (MTU), 2021

Sean Dudley, Ph.D. Materials Science (MTU), 2021

Emily Kooistra-Manning, M.S. General Engineering, 2020

Taylor Winsor, M.S. Materials Science & Engineering, 2020

Johnathan Feldman, M.S. Geochemistry, 2019

Seth Grinde, M.S. General (Mechanical) Engineering, 2018

Richard Ladouceur, Ph.D. Materials Science, 2018

John Murphy, Ph.D. Materials Science, 2018

Tyler Brodin, M.S. Metallurgical and Mineral Processing Engineering, 2016

Sara Edinburgh, M.S. Geosciences, 2016

Grant Wallace, M.S. Metallurgical and Materials Engineering, 2015

Nick Gow, Ph.D. Individualized Interdisciplinary Program (IIP), 2015

Brandon Steinborn, M.S. Metallurgical and Materials Engineering, 2013

Keri Caldwell, M.S. Metallurgical and Materials Engineering, 2012

Minho Song, Ph.D. Metallurgical Eng., Royal Institute of Technology (KTH), Stockholm SWE, 2011

John Hoover, M.S. Mining Engineering (non-thesis), 2011

Michelle McKnight, M.S. Environmental Engineering (non-thesis), 2011

Ryan Christianson, M.S. Metallurgical and Mineral Processing Engineering (non-thesis) 2010

Mariam Melashvili, M.S. Metallurgical and Mineral Processing Engineering, 2009

Nick Gow, M.S. Metallurgical and Mineral Processing Engineering, 2008

**FUNDED GRADUATE RESEARCH PROJECTS**

Development of a low carbon technology for the recovery of critical metals from waste metallurgical slags with waste energy recovery – U.S. Department of Energy (EPSCoR); $700,804 (Total funding for 3 years) *in progress*.

Materials Technology for Rare Earth Element Processing (MT-REEP) – US Army Research Laboratory (ARL); $453K to the Downey Lab for Year 1 of a 5-year Cooperative Research Agreement (Total funding $24,625,000); *in progress*.

Materials Technology Research for Army Modernization and Readiness (MT-RAMR) – US Army Research Laboratory (ARL) Cooperative Agreement W911NF-20-2-0163; $754K to the Downey Lab (Synthesis and Sintering of Ceramic and Composite Materials) for years 1-2 of a 5-year Cooperative Research Agreement (Total funding $23,899,986); *in progress*.

Consortium for Research on Environmental Water Projects (CREWS Core Project I – Metal Contaminant and Nutrient Enrichment in the Upper Clark Fork River); $450K to the Downey Lab for 5-year project by National Science Foundation Experimental Program to Stimulate Competitive Research (NSF EPSCoR RII Track-1); *in progress*.

Materials Technology Science and Engineering Research for the Army (MT-SERA) W911NF-15-0020; $2.6M to the Downey Lab (Synthesis and Sintering of Ceramic and Composite Materials) for the 5-year Cooperative Research Agreement with ARL; completed Fall 2020.

Recycling of Tantalum-bearing Waste Materials to Recover Tantalum Metal, funded ($47K) by the Idaho National Laboratory; completed Spring 2018.

Recovery of Metal Contaminants from Industrial Wastewaters with Magnetic Nanocomposites in a Novel Continuous Flow Process System; funded ($495K) by the Montana University System Research & Economic Development Initiative; completed Summer 2017.

Extraction and Selective Separation of Rare Earth Elements from Naturally Occurring and Scrap/Waste Matrices; funded (~$100K) by ARL; completed Fall 2016.

Chlorination, Bromination, and Vapor Phase Extraction of Rare Earth Elements contained in various Matrices; funded ($478K) by ARL; completed Spring 2015.

Improved Methods of Copper and Silver Extraction from Troy Mine (Montana) Flotation Concentrate; funded ($25K) by Troy Mine, Inc. (Revett Minerals); completed summer 2014.

Chlorination and Vapor Phase Extraction of Rare Earth Element Concentrate from the Bear Lodge Property, Wyoming; funded ($15K) by Rare Element Resources; completed May 2013.

Vapor Phase Extraction of Rare Earth Oxide Contaminants from Fluorite-Structure Nodules on Pyroprocessed Nuclear Fuel Substrate; funded ($50K) by INL; completed May 2012.

Fabrication and Characterization of Porous 420 Stainless Steel Substrates Produced by Rapid Prototyping Technology and Thermally Strengthened by Solid State Sintering; funded by various agencies through the Center for Advanced Mineral and Metallurgical Processing (CAMP); completed May 2011.

Electroless Plating of Palladium on Stainless Steel Substrates in Hydrazine Solutions: A Study of the Relationships between Bath Parameters, Deposition Mechanisms, and Deposit Morphologies; funded by various agencies through the Center for Advanced Mineral and Metallurgical Processing (CAMP); completed April 2011.

**FUNDED GRADUATE RESEARCH PROJECTS, continued**

Evaluation of Fly-Ash-Based Artificial Zeolite Formation as Treatment for Salt-Laden Process Water from Eastern Montana Coal Operations; funded by DOE (CAST Program), Great Northern Properties, Montana Board of Research Commercialization and Technology, and the Center for Advanced Mineral and Metallurgical Processing (CAMP); completed April 2011.

Density Measurements in the CaO-SiO2-MgO System (1500-1700°C); funded ($35K) by Elkem Solar; completed July 2010.

Critical Evaluation of the Experimental Methods used to Determine Chemical Diffusivity of Impurity Species in the CaO-SiO2-MgO Slag System; funded ($35K) by Elkem Solar; completed August 2009.

Effect of Varying Optical Basicity on Slag Viscosity in the CaO-SiO2-MgO System; funded ($35K) by Elkem Solar; completed November 2009.

Ferrihydrite and Aluminum-Modified Ferrihydrite Enhanced High-Density Sludge Treatment for Removing Dissolved Metals from Acid Mine Drainage, funded ($20K) by EPA/DOE (2007-2008); completed Fall 2008.

**SERVICE**

**CAMPUS COMMITTEES**

CAMP Advisory Board (2018-present)

Research Advisory Council (2008-present)

Graduate Research Council (2016-present)

Collegiate Evaluation Committee (2017-19)

Distinguished Researcher Selection Committee (2017-18)

MUS Performance-Based Funding Steering Committee (2013-2015)

Montana Tech Faculty Senate (2007-2014); Vice Chair (F 2010); Chair (S 2011- S 2014)

Honors Program Committee (2010-2011)

Merit Plan Committee (2008-2009; 2011)

Bright Prism Scholarship Committee (2010)

Advising/Retention Steering Committee (2006-09)

Safety Committee (2006-09)

Montana Tech Vision Task Force (2006)

Search Committees:

M&ME Dept. Faculty – Nucor Professor (Spring 2023)

Dean, School of Mines and Engineering (Ay 2021-22)

Vice Chancellor for Research/Graduate School Dean (AY 2020-21)

M&ME Dept. Faculty (AY 2020-21)

Instructional Designer (AY 2019-20)

Montana Tech Chancellor (Spring 2019)

CAMP Laboratory Director (Spring 2019)

Dean, School of Mines and Engineering (2017)

Mining Engineering Department Faculty (Fall 2014)

Director, Montana Bureau of Mines & Geology (2012)

CAMP Director (Chair 2009-2011, Spring 2014)

Montana Tech Chancellor (Spring 2011)

M&ME Dept. Faculty (Summer 2007, Spring 2011, Spring 2017)

M&ME Dept. Laboratory Director (Spring 2007)

**PROFESSIONAL SOCIETIES**

American Institute of Chemical Engineers (AIChE); member 1992- present

The Metals, Minerals, and Materials Society of AIME (TMS); 1976- present

TMS Pyrometallurgy Committee (member 1997- present; Chair 2010-2012; Vice Chair 2008-2010)

Co-organizer, 11th International Symposium on High Temperature Metallurgical Processing, held in conjunction with the 2020 TMS Annual meeting in San Diego, California in February 2020; Co-Editor of Symposium Proceedings; Session Chair

Co-organizer, 10th International Symposium on High Temperature Metallurgical Processing, held in conjunction with the 2019 TMS Annual meeting in San Antonio, Texas in March 2019; Co-Editor of published Symposium Proceedings; Session Chair

Co-organizer, 9th International Symposium on High Temperature Metallurgical Processing, held in conjunction with the 2018 TMS Annual meeting in Phoenix, Arizona, March, 2018; Co-Editor of published Symposium Proceedings; Session Chair

Co-organizer, Drying, Roasting, and Calcining of Minerals Symposium, held in conjunction with the 2015 TMS Annual meeting in Orlando, Florida, March, 2015; Co-Editor of published Symposium Proceedings; Session Chair

Lead Organizer, International Symposium on Fluidization Technologies for the Mineral, Materials, and Energy Industries, held in conjunction with the 2014 TMS Annual Meeting, San Diego, CA, Feb. 2014; Co-Editor of published Symposium Proceedings; Session Chair

Plenary Session Chair, International Symposium on High Temperature Electrochemistry, held in conjunction with the 2013 TMS Annual Meeting in San Antonio, Texas, March, 2013

Lead Organizer, International Smelting Technology Symposium (incorporating the 6th Advances in Sulfide

Smelting Symposium), held in conjunction with the 2012 TMS Annual Meeting in Orlando, Florida, March, 2012; Co-Editor of the published Symposium Proceedings; Session Chair

Co-organizer, 2nd International Symposium on High-Temperature Metallurgical Processing, held in conjunction with the 2011 TMS Annual Meeting in San Diego, California, February 27-March 3, 2011. Co-Editor of the published Symposium Proceedings; Session Chair

Co-organizer, International Symposium on High-Temperature Metallurgical Processing, held in conjunction with the 2010 TMS Annual Meeting in Seattle, Washington, February, 2010; Session Chair

**PROFESSIONAL EXPERIENCE (NON-ACADEMIC)**

**2006 to present: Chief Executive and General Manager, J. P. Downey & Associates, P.L.L.C.**

Consulting activities on behalf of private sector clients in the chemical, metallurgical, and materials industries. Activities include professional witness, technical assistance, experimental design, equipment selection and operation, data analysis, cost estimation, and reporting.

**2000 to 2005:** **Vice President,** **Hazen Research, Inc., Golden, Colorado**

**1996 to 2000:** **Senior Project Manager**

**1991 to 1996:** **Project Manager**

Member of the corporate Operating Management Group, which held responsibility for all aspects of corporate planning and management, including setting objectives, deciding priorities to accomplish objectives, and maintaining business quality.

Primary responsibility for the direction and development of the Thermal Processing Department, including development and maintenance of department budgets and schedules; technical review of proposals, work plans, and reports; establishment of safety and quality control standards; resolution of contractual matters; and supervision of technical staff of project managers and engineers in activities ranging from fundamental process research and development to the construction and operation of pilot-scale demonstration plants.

Technical responsibilities included oversight of hundreds of research projects performed on behalf of clients in the mining, chemical, energy, and environmental sectors. Developed projects from initial client contact and proposal preparation through final reporting and project closure.

Representative examples of projects and achievements:

* Principal Investigator for DOE sponsored research to evaluate the application of a novel hybrid magnetic field reactor to wastewater treatment.
* Principal Investigator for NSF sponsored research into the production of nanocrystalline advanced ceramics; developed process for synthesizing high-purity boron nitride.
* Developed a matte smelting process for treatment of metal-laden scale and other residue from geothermal wells; achieved high recovery of copper and precious metals while rejecting potentially hazardous impurities into an environmentally acceptable slag.
* Evaluated a pyrometallurgical process for extracting metal values from lead smelter flue dust; process was highly selective in concentrating lead and silver in bullion, while rejecting arsenic, antimony, indium, and zinc to a marketable dross phase.
* Designed and managed a pilot plant program to evaluate a two-stage thermal process for producing high-purity tungsten carbide powder. Developed an alternative process for continuously producing tungsten carbide powder.
* Applied thermal desorption, pyrolysis, and thermal oxidation technologies to remediate RCRA- and TSCA-regulated wastes. Experience includes treatability studies to investigate removal of polychlorinated biphenyls and other hazardous organic and inorganic compounds from contaminated soils, sludges, and sediments. Served as the primary TSCA permit contact with EPA.
* Designed and conducted a detailed characterization of radionuclide-contaminated soil and sediment samples. Developed process design criteria for liberation and physical separation of radionuclides substrate particles; resultant data formed design basis for site remediation process.

* Managed a bench-scale evaluation of thermal processing alternatives for recovering nickel and destroying the hazardous components in an organometallic process stream; project included engineering evaluation and comparative economic analysis of pyrolysis, thermal oxidation, and injection smelting.
* Managed pilot-scale evaluation of a process for pyrolyzing the polymeric fraction of electronic scrap by injection in a molten metal bath. Also evaluated destruction capability of the process as applied to surrogate nerve agent.
* Formulated methods for selective removal and/or passivation of lead contained in brass plumbing fixtures. Guided process development from initial evaluation through commercial implementation at client's production facilities. Developed quality control procedures for the commercial operation.
* Devised experimental systems to evaluate the high-temperature oxidation characteristics of austenitic stainless steel and high-nickel alloys to provide the basis for selecting alloys for service as heat exchanger tubes.
* Managed development of a fluidized-bed pyrolysis process to recover the caprolactam monomer from nylon-6 carpet waste.

**1989 to 1991:** **Graduate Research Assistant,** **Colorado School of Mines, Golden, Colorado**

Thesis work related to the thermal treatment of electric arc furnace (EAF) dust. Prepared and delivered lectures in Metallurgical Thermodynamics and Pyrometallurgy.

**1984 to 1989:** **Metallurgical Engineer,** **U.S. Bureau of Mines, Lakewood, Colorado**

* Managed contracts with external engineering companies. Prepared request for proposal documentation, chaired contractor selection committees, and monitored contractor performance. Developed process flow sheets, material and energy balances, and detailed capital and operating cost estimates for mineral processing, metallurgical, and environmental systems. Generated computer models and spreadsheets for technical and economic evaluation.
* Technical Project Officer for a series of studies to investigate the technologies and economics of the mining, mineral processing, metallurgical operations in the aluminum, copper, lead, and zinc industries. Prepared request for proposal documentation, chaired contractor selection committees, and oversaw projections through completion and submittal of final reports. Monitored and guided contractor performance throughout the contract term.
* Project Leader for developing capital and operating cost models for the extractive metallurgical industries. Verified data submitted by USBM and contractor personnel; technical review of capital and operating cost estimates for alumina refineries, aluminum smelters, lead smelters and refineries, and electrolytic zinc facilities; assessed environmental legislation compliance costs.
* Developed capital and operating cost estimates for various mineral processing, metallurgical, and environmental systems. Efforts included comprehensive analyses of systems for comminution circuits, leachate collection and containment, and tailings disposal. Generated detailed operating cost estimates for copper and lead smelters and refineries. Developed cost estimation models.
* Supervised revision of the USBM Cost Estimation System Handbook for mining and mineral processing unit operations. Directed personnel in the development of engineering data and the application of derived data in the creation of new and revised Handbook sections. Guided USBM engineers and scientists in cost estimation procedure. Critiqued over two hundred cost estimates.
* Developed process flow sheets, material and energy balances. Provided technical and editorial review for many USBM reports. Contributed technical assistance and administrative support to USBM management. Provided expertise to projects being conducted by USBM, other government agencies, and industry.

**1981 to 1983:** **Project Metallurgist,** **Anschutz Mining Corporation, Denver, Colorado.**

* Analyzed technical and economic feasibility of the development of various precious metal, base metal and industrial mineral prospects. Led process development efforts and ensured the technical feasibility of the metallurgical unit operations under development. Formulated comprehensive process design criteria for an integrated concentrator, roaster, and hydrometallurgical refinery.
* Worked with metallurgical consultants under contract to the Corporation. Served as liaison with domestic and foreign research, engineering, and equipment supply contractors. Assisted in contract document preparation, contractor evaluation and selection.
* Developed a thermal process for producing high purity arsenic trioxide from tungsten concentrator tailings. Demonstrated process applicability to purifying tungsten concentrate.

**1977 to 1981:** **Process Engineer,** **Anaconda Minerals Corporation, Anaconda, Montana.**

* Provided technical assistance for 500-ton-per-day primary copper smelter and auxiliary plants. Managed operation and maintenance of metal production and related environmental facilities. Supervised operations personnel.
* Planned and executed metallurgical evaluations involving bench, pilot, and full-scale unit operations. Responsible for startup, data accumulation and verification, and the implementation of new operating procedures based on experimental results. Trained operating personnel in new equipment and procedures.
* Appointed Plant Engineer for pilot testing of a hydrometallurgical process for treating copper smelter flue dusts. The process included electrolytic recovery of copper, recovery of lead and silver concentrate, and stabilization of arsenical tailings.
* Developed a process for neutralization of smelter wastes. Supervised construction and commissioning of the full-scale facility.
* Devised and implemented a procedure for removing colloidal carbon impurities from sulfuric acid.

**PUBLICATIONS AND PRESENTATIONS**

**JOURNALS AND CONFERENCE PROCEEDINGS**

Development of an Experimentally Derived Model for Molybdenum Carbide (Mo2C) Synthesis in a Fluidized-Bed Reactor. Advances in Powder and Ceramic Materials Science. Springer, Cham, pp 17–25.

Water Treatment Method for Removal of Select Heavy Metals and Nutrient Ions through Adsorption by Magnetite, ACS ES&T Water, 2022, https://doi.org/10.1021/acsestwater.2c00242.

On the Sintering Behavior of Nb2O5 and Ta2O5 Mixed Oxide Powders, *Materials* 2022, 15, 5036. https://doi.org/10.3390/ma15145036

Thermal Analysis of Potential High Entropy Alloy Binder Alternatives for Tungsten Carbide, The 12th International Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Society, TMS Springer 2022, 175-183.

Evaluation of Processing Parameters for the Production of Tungsten Carbide in a Fluidized Bed Reactor, The 12th International Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Society, TMS Springer 2022, 393-401.

Liberation and Separation of Ultrafine Tungsten Carbide Particles from an Activated Carbon Substrate, ACS Sustainable Chemistry & Engineering, https://doi.org/10.1021/acssuschemeng.1c07261.

Transformation of a Ceramic Precursor to a Biomedical (Metallic) Alloy: Part I Sinterability of Ta2O5 and TiO2 Mixed Oxides, Materials Science for Energy Technologies (5), 2022, 181-188.

Optimization of the Process Parameters for the Synthesis of Mo2C on an Activated Carbon Matrix,” The 11th Int’l Symposium on High Temperature Metallurgical Processing, The Minerals, Metals, and Materials Series, TMS Springer, 2020, 715-724.

Continuous Flow Process for Removal and Recovery of Water Contaminants with Magnetic Composites, Nanocomposites VI: Nanoscience and Nanotechnology in Advanced Composites – Polymer and Other Nanocomposites, The Minerals, Metals, and Materials Series, TMS Springer, 2019, 155-164.

Computational Polyethylene-Ceramic Composite Plate Design and Optimization, TMS 2020 149th Annual Meeting & Exhibition Supplemental Proceedings, The Minerals, Metals, and Materials Series, TMS Springer, 2020, 1489-1498.

Effective separation of magnetite nanoparticles within an industrial-scale pipeline reactor, Separation Science and Technology, DOI: [10.1080/01496395.2019.1646762](https://doi.org/10.1080/01496395.2019.1646762)

Statistical Optimization of Tungsten Carbide Synthesis Parameters, *10th International Symposium on High-Temperature Metallurgical Processing*, TMS, 2019, 371-378.

Density Separation of Mixed Carbide Colloids via Standing Wave Physics, TMS 2019 *148th Annual Meeting Supplemental Proceedings*, TMS, 2019, 1521-1532.

Synthesis of Nanocrystalline Carbide Ceramics via Reduction of Anion-Loaded Activated Carbon Precursors, 9*th International Symposium on High-Temperature Metallurgical Processing*, The Minerals, Metals, and Materials Series, TMS, 2018, pp. 125-134.

Synthesis of Carbide Ceramics from Activated Carbon Precursors loaded with Tungstate, Molybdate, and Silicate Anions, *Advances in Ceramics for Environmental, Functional, Structural, and Energy Applications*, Ceramic Transactions Vol. 265, The American Ceramics Society, John Wiley & Sons, 2018, pp. 137-149.

**JOURNALS AND CONFERENCE PROCEEDINGS, continued**

Effects of Oxide Precursor Preparation on the Electrochemical Reduction of Tantalum Pentoxide in Calcium Chloride Melt, *The Minerals Metals and Materials Society, TMS 2017 146th Annual Meeting & Exhibition Supplemental Proceedings*, 2017, pp. 651-655.

Selective Separation of Rare Earth Chlorides utilizing Vapor Phase Extraction, Rare Metal Technology 2017, The Minerals, Metals, and Materials Society Series, TMS, 2017, pp. 55-63.

Synthesis of Carbide Ceramics via Reduction of Adsorbed Anions on an Activated Carbon Matrix, 8th International Symposium on High-Temperature Metallurgical Processing, The Minerals, Metals, and Materials Series, TMS, 2017, pp. 49-57.

Sulfation Roasting of a Bornite Flotation Concentrate to Optimize Silver Extraction in a Ferric Chloride Leach, Drying, Roasting, and Calcining of Minerals, TMS (The Minerals, Metals, & Materials Society), 2015, pp. 3-10.

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Bromination of Rare Earth Elements, Drying, Roasting, and Calcining of Minerals, TMS (The Minerals, Metals & Materials Society), 2015, pp. 19-26.

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Experimental Determination of Density in Molten Lime Silicate Slags as a Function of Temperature and Composition, Mineral Processing and Extractive Metallurgy (TIMM C), Volume 123, pp. 178-183, Number 3, September 2014.

Forecasting Drill Bit Consumption in Surface Mine Production Drilling Operations, 2012 Transactions of the Society for Mining, Metallurgy and Exploration, Vol. 332, pp. 414-421.

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Improved Palladium Coatings for Hydrogen Purification Applications, Energy 2012: Materials in Clean Power Systems VII: Clean Coal, Hydrogen-Based Technologies, and Fuel Cells, TMS, 2012, pp. 331-338.

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A Magnetic-Field Reactor for Metal Removal from Dilute Wastewater Streams, Hydrometallurgy 2008 – Proceedings of the Sixth International Symposium, SME, pp. 162-168.

Removal of As(V) and Cr(VI) Ions from Aqueous Solution using a Continuous Hybrid Field Gradient

Magnetic Separation Device, Separation Science and Technology, 2006, Vol. 41, No. 15, pp. 3297-3312.

Process Development Strategies for Mercury Remediation, Mercury Management Symposium, 2003, TMS, San Diego, CA.

**JOURNALS AND CONFERENCE PROCEEDINGS, continued**

Planning and Conducting a Successful Thermal Process Demonstration Program, The Nineteenth IT3 Conference, Portland, OR (2000).

Application of Thermal Technology to Arsenic Remediation Problems, Global Symposium on Recycling, Waste Treatment, and Clean Technology, San Sebastian, Spain (1999).

Recycling Lead and Zinc in the United States, International Symposium on the Hydrometallurgical and Pyrometallurgical Processing of Zinc and Lead, Calgary, Alberta, Canada (1998).

Thermal Desorption Treatability Studies: Removing Chlorinated Organic Compounds from Soils, First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA (1998).

Process Development Strategies for Mercury Remediation, Mercury Management Symposium, 2003, TMS, San Diego, CA.

Planning and Conducting a Successful Thermal Process Demonstration Program, The Nineteenth IT3 Conference, Portland, OR (2000).

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Thermal Desorption Treatability Studies: Removing Chlorinated Organic Compounds from Soils, First International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA (1998).

Secondary Zinc Production and Waste Minimization, Poll. Engineering, 1994, Vol. 26, No. 12, pp.42-44.

Evaluation of a Process for Separation and Recovery of Indium and Lead from Smelter Flue Dust, International Symposium on Extraction and Processing for the Thermal Treatment of Wastes, 1994, TMS, San Francisco, CA.

Removal of Halogens from EAF Dusts by Pyrohydrolysis, International Symposium on Processing of

Residues and Effluents, 1992, TMS-AIME Annual Meeting, San Diego, CA.

Recovery of High Purity Arsenic Trioxide from Arsenopyrite, Frontier Technology in Mineral Processing, Society of Mining Engineers (SME) Annual Meeting, 1994, New York, NY.

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Thermal Treatment Alternatives for Phosphorus-Contaminated Arc Furnace Wastes, 2004

Theoretical Evaluation of a Cyclone Boiler Slag Composition, 2002

Direct Reduced Iron Shaft Furnace Pilot Plant Campaign, 2001

Refractory Gold Ore Roasting – A Literature Survey, 2001

Bench-Scale Evaluation of Lead and Tin Recovery from Electroplating Sludge, 2001

Tungsten Carbide Synthesis Demonstration Plant Design Criteria, 2000

Investigation of a Novel Thermal Method of Synthesizing Nanocrystalline Advanced Materials, 2000

Pilot Plant Evaluation of a Tungsten Carbide Synthesis Process, 2000

TBRC Smelting of Electronic Scrap and Other Secondary Materials, 1999

Evaluation of Ash Fusion Characteristics, 1998

Evaluation of Alternative Methods of Controlling Sulfur Emissions in Chlorinator Discharge Gas, 1997

Evaluation of Potential Applications for High-Temperature Fluidized-Bed Technology, 1997

Process Development for a Flux Recovery Facility – Phase 2 Laboratory Program, 1997

Laboratory Evaluation of Sodium Tungstate Production Process, 1996

Control of Lead Leaching from Leaded Brass Fixtures, 1996

Development of an Aluminum Carbide Production Process – Phase 1, 1996

Process Development for a Flux Recovery Facility – Phase 1 Process Evaluation, 1996

Tantalum Pickling Solution Development – Part 1, 1996

Pilot System Evaluation of a Two-Stage Pyrometallurgical Tungsten Carbide Production Process, 1995

Treatment of Zinc-Containing Fly Ash, 1995

Findings on Study to Improve (Refractory Metal Production) Operations, 1995

Thermal Treatment of Process Streams from a (Petrochemical) Production Facility, 1995

Characterization and Pilot-Scale Testing of Tungsten-Bearing Materials, 1995

Pilot-Scale Treatability Testing of PCB-Contaminated Soil Samples from (Former Commercial Aluminum Smelter) Sites, 1994

Findings on Study to Improve (Refractory Metal Production) Operations, 1995

High Temperature Oxidation Testing of Selected Alloys, 1993

Production of Indium-rich Dross, 1993

Bench-scale Testing of Technologies for Producing Marketable Products from Geothermal Scale, 1993

**SELECTED TECHNICAL REPORTS, continued**

Molten Metal Processing of DOE and Dursban Insecticide Wastes, 1993

Production of Copper Oxide Powder, 1992

Characterization of Radionuclide-Contaminated Soil Samples, 1992

**PATENTS**

High Purity Silicon-Containing Products and Method of Manufacture, U.S. Patent 8,470,279 (2013)

A Method for Reducing Lead Leaching in Fixtures*,* U.S. Patent 5,904,783 (1999)

Pyrometallurgical Process for Forming Tungsten Carbide, U.S. Patent 5,882,620 (1999)

Process for Stabilization of Arsenic, U.S. Patent 5,762,891 (1998)

Apparatus and Method for Inhibiting the Leaching of Lead in Water, U.S. Patents 5,544,859,

5,632,825, and 6,013,382 (1996, 1997, and 2000, respectively)

Process for Reducing Lead Leachate in Brass Plumbing Fixtures, U.S. Patent 5,454,876 (1995)

Sequential Flotation of Sulfide Ores, U.S. Patent 4,460,459 (1982)

**PROFESSIONAL AFFILIATIONS**

Registered Professional Engineer (Chemical Engineering), Colorado Lic. 28329 and Montana Lic. 5381

Center for Advanced Materials Processing (CAMP) Advisory Board, 2008-2013, 2018-present

Minerals, Metals and Materials Society (TMS) of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), 1977-present

American Institute of Chemical Engineers (AIChE), 1992–present

Montana Tech Metallurgical and Materials Engineering Department Industrial Advisory Board, 2001-05

Industrial Advisory Board for the Center for Micro-engineered Materials, University of New Mexico and Rutgers University, 1999–2002

Montana Tech Alumni Association 1977-present; served on Board of Directors, 1981-82

**HONORS AND AWARDS**

Montana Tech Lifetime Distinguished Researcher Award (2023)

Montana Tech Distinguished Researcher Award (2016)

Montana Tech Faculty Merit Award (2013, 2016)

Executive Editor, International Journal of Metallurgical & Materials Engineering (2015 – present)

Goldcorp Professorship (2009 – present)

Hazen Research Professor of Extractive Metallurgy (2014)

Academic Fellow, Center for Advanced Mineral Processing, (2006)

Montana Tech Alumni Recognition Award (1996)