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Summary

- Professor and Chair of Materials Science and Engineering at Missouri University of Science and Technology.
- Demonstrated record of excellence in teaching and research. Missouri S&T's Faculty Excellence Award in 2019. AIME James A. Douglas Gold Medal for technical contributions in nonferrous metallurgy. Five-time Boots Clayton Award winner. Extraordinary Faculty/Staff Award from S&T Student Council in 2018.
- Assisted multiple major copper companies in energy efficiency and production improvements through research and consulting. Conducted onsite training for electrowinning or electrorefining for metallurgical operations on six continents.
- Focused on enhancing the educational experience of MSE students leading to changes in the departmental PhD qualifying exam, teaching many MET courses to ensure timely matriculation of students, and creating of three graduate certificates.
- Dedicated to improving diversity in engineering. Advised three graduate students from Ghana and six female graduate students from China, India, Thailand and the U.S.A. On search committees that recommended first female MET ENG associate professor and Associate Dean of Research for CEC.
- Provided leadership through service within the Society of Mining, Metallurgy and Exploration as MPD Division chair, co-chair of Extraction 2018 and lead chair for Extraction 2025 and coordinator of the international Copper Refinery Group.
- Project leader for three international research projects funded by Amira Global and European Sponsors' Group. Active research in critical minerals and copper extractive metallurgy. Led over $7 million in externally funded research grants.

Professional Preparation

University of Arizona	Materials Science and Engineering	Ph.D. 1998
University of Missouri-Rolla	Metallurgical Engineering	M.S. 1995, B.S. 1992

Appointments

2022-present	Chair, Materials Science and Engineering, Missouri S&T, Rolla, MO
2019-present	Professor, Materials Science and Engineering, Missouri S&T, Rolla, MO
2012-present	Research Investigator, Materials Research Center, Missouri S&T, Rolla, MO
2005-present	Manager and Owner, MSM Consulting, LLC, Rolla, MO
2021-2022	Interim Chair, Materials Science and Engineering, Missouri S&T, Rolla, MO
2017-2021	Associate Chair for Graduate Programs, MSE Department, Missouri S&T, Rolla, MO
2012-2019	Associate Professor, Materials Science and Engineering, Missouri S&T, Rolla, MO
2016-2018	Dean's Scholar, College of Engineering and Computing, Missouri S&T, Rolla, MO
2005-2012	Various Faculty Positions in Metallurgical Engineering, University of Utah, Salt Lake City, UT
2003-2005	Various Research and Management Positions, ELTECH Systems Corp., Fairport Harbor, OH
1992-1993	Assistant Metallurgical Engineer, ARMCO Grinding Systems, Kansas City, MO

Honors and Awards

2022, 2019, 2018, 2015, 2013 **Boots Clayton Award**, Missouri S&T – Student voted most caring MET professor
2022, 2018 Most Outstanding Metallurgical Engineering Faculty, MSE, Missouri S&T – student voted
2015-2016, 2016-2017, 2019-2020 Outstanding Teaching Commendation, Missouri S&T
2019 Missouri S&T Faculty Excellence Award for sustained excellence in teaching, research and service.
2017-2018 Outstanding Teacher Award, Missouri S&T
2018 Extraordinary Faculty/Staff Award, Missouri S&T Student Council
2018 **James Douglas Gold Medal**, AIME (TMS/SME) for distinguished achievement in nonferrous metallurgy
2018 Millman of the Year, SME-MPD, presented to outgoing Chair of the Division
2016-2018 Dean's Scholar, College of Engineering and Computing, Missouri S&T
2009, 2011 Outstanding Faculty Teaching Award, Department of Metallurgical Engineering, Univ. of Utah
2011 Mines and Metallurgy Academy, Missouri S&T

Publications (ORCID 0000-0001-9288-076X)

Scopus - h-index 24, i10-index 43, citations 1904 (as of 02/01/2023)
Google Scholar – h-index 28, i10-index 57, citations 2719 (as of 02/01/2023)

Journal Articles Since 2020 (59 total)

1. Bauer, J., & Moats, M. (2022). Analytical and Approximate Current Distributions in the Rotating Cylinder Hull Cell. Journal of The Electrochemical Society, 169(12), 123504.
2. Fletcher, J. B., & Moats, M. S. (2022). Understanding Charge Effects on Marked Ball Wear Rates: a Corrosion Study— Part 1. The Impacts of pH and Chloride Concentration, Mining, Metallurgy & Exploration, 1-8.
3. Fletcher, J. B., & Moats, M. S. (2022). Understanding Charge Effects on Marked Ball Wear Rates: a Corrosion Study—Part 2. The Impact of Chromium Content in Media and Dissolved Oxygen. Mining, Metallurgy & Exploration, 9-17.
4. Nassar, N., Kim, H. Frenzel, M., Moats, M., & Hayes, S. (2022). Global tellurium supply potential from electrolytic copper refining. Resources, Conservation & Recycling.
5. Verbruggen, F., Prévoteau, A., Bonin, L., Marcoen, K., Hauffman, T., Hennebel, T., ... & Moats, M. S. (2022). Electrochemical codeposition of copper-antimony and interactions with electrolyte additives: Towards the use of electronic waste for sustainable copper electrometallurgy. Hydrometallurgy, 105886.
6. de las Torres, A. G., Ríos, G., Almansa, A. R., Sánchez-Rodas, D., & Moats, M. S. (2022). Solubility of bismuth, antimony and arsenic in synthetic and industrial copper electrorefining electrolyte. Hydrometallurgy, 208, 105807.
7. Mohammed, A. J., & Moats, M. (2022). Effects of Carrier, Leveller, and Booster Concentrations on Zinc Plating from Alkaline Zincate Baths. Metals, 12(4), 621.
8. Bauer, J., & Moats, M. (2022). Nodule Formation on Copper Electrodeposits in the Rotating Cylinder Hull Cell. Metallurgical and Materials Transactions B, 1-10.
9. Verbruggen, F., Ostermeyer, P., Bonin, L., Prévoteau, A., Marcoen, K., Hauffman, T., ... & Moats, M. S. (2022). Electrochemical codeposition of arsenic from acidic copper sulfate baths: The implications for sustainable copper electrometallurgy. Minerals Engineering, 176, 107312.
10. Moats, M., Alagha, L., & Awuah-Offei, K. (2021). Towards resilient and sustainable supply of critical elements from the copper supply chain: A review. Journal of Cleaner Production, 127207.
11. Verbruggen, F., Fiset, E., Bonin, L., Prévoteau, A., Moats, M. S., Hennebel, T., & Rabaey, K. (2021). Stainless steel substrate pretreatment effects on copper nucleation and stripping during copper electrowinning. Journal of Applied Electrochemistry 51 (2), 219-233. https://doi.org/10.1007/s10800-020-01485-2
12. Da Silva, T. R., Majuste, D., Bauer, J., & Moats, M. S. (2020). Effect of zinc ions on copper electrodeposition in the context of metal recovery from waste printed circuit boards. Hydrometallurgy 198, 105513. https://doi.org/10.1016/j.hydromet.2020.105513.
13. de las Torres, A. I. G., Moats, M. S., Ríos, G., Almansa, A. R., & Sánchez-Rodas, D. (2020). Arsenic and antimony speciation analysis in copper electrolyte by liquid chromatography coupled to hydride generation atomic fluorescence spectrometry (HPLC-HG-AFS). Analytical Methods, 12(14), 1943-1948.
14. Lee, J, Bazalian, M, Sovacool, B, Hund, K, Jowitt, S M, T P, Nguyen, A, Manberger, Kah, M, Greene, S, Galeazzi, C, Awuah-Offei, K, Moats, M, Tilton, J and Kukoda, S (2020) Reviewing the material and metal security of low-carbon energy transitions. Renewable and Sustainable Energy Reviews, 124, 109789.

Conference Proceedings most important listed (69 total)

1. S. Wang, D. Kim and M. Moats (2013). Determination and Control of Bismuth Contamination in Copper Electrorefining, In Copper 2013, Volume V Electrowinning/Electrorefining, pp. 577 – 594. **Includes formula that predicts bismuth in copper electrorefined copper. Similar formula now used to control copper smelter output.**
2. Y. Khouraibchia and M. Moats (2010) Evaluation of Copper Electrowinning Parameters on Current Efficiency and Energy Consumption Using Surface Response Methodology. In Electrochemistry in Mineral and Metal Processing VIII ESC Transactions Vol. 28 No. 6 (Eds. F.M. Doyle, R. Woods and G.H. Kesall), pp. 295-306. **Includes formula to predict current efficiency controlled by ferric reduction in copper electrowinning. Formula was further modified and validated by world's largest copper electrowinning company. It has been used as a benchmarking tool for their operations.**

3. P. Gupta and M. S. Moats, "DBC extraction of gold, copper, bismuth, selenium and silver from slimes processing leachate", Pre-print 10-023, SME Annual Meeting, Phoenix, AZ, Mar. 3, 2010. **Company used this work to design and construct a new gold recovery circuit.**

Books

1. W. Davenport, M. King and M. Moats (2013) Sulfuric Acid Manufacture: 2nd Edition, Elsevier.
2. Crundwell, F. Moats, M., Ramachandran, V., Robinson, T. and Davenport, W. G. (2011) Extractive Metallurgy of Nickel, Cobalt and Platinum Group Metals, Elsevier.

Policy Briefs

1. M. M. Foss, M. S. Moats, K. Awuah-Offei (2020) FRAMING ENERGY AND MINERALS FOR FUTURE PATHWAYS, G20 Saudi Arabia, Policy Brief, Task Force 10, Policy Brief 12, Nov. 25, 2020. https://www.g20-insights.org/policy_briefs/framing-energy-and-minerals-for-future-pathways/

Presentations since 2020 (98 total)

1. Keynote. "Where have all the smelters gone? America's dependency on foreign non-ferrous metal production", NSF WORKSHOP: RESILIENT SUPPLY OF CRITICAL MINERALS, August 3, 2021.
2. Invited. Testimony on "Critical Minerals: Addressing Supply Chain Challenges and Rising Demand" to the House Committee on Natural Resources Republican Members, U.S. House of Representatives, May 18, 2021
3. "Critical Mineral Potential and Recovery from Copper Production", Critical Materials Institute, March 3, 2021.
4. Invited. "Analysis of Select Critical Mineral Supply Chains", Rice University, Baker Institute Energy and Minerals Roundtable, February 3, 2021.
5. Invited. "Analysis of Select Critical Mineral Supply Chains", Atlantic Council, The Geopolitics of Critical Mineral Supply Chains, January 18, 2021.
6. Invited. "Critical Mineral Potential and Recovery from Copper Production", Michigan Tech, Chemical Engineering Seminar, September 11, 2020.
7. Invited. "Challenges to Creating Resilient Supply of Critical Minerals in North America", Rice University, Baker Institute Energy and Minerals Roundtable, June 5, 2020.
8. "Optimizing Additive Ratios in Alkaline Zincate Electrodeposition", PnZn 2020, San Diego, CA, February 24, 2020
9. "To Polarize or Not to Polarize: Practical Advice on How to Control Zinc Electrodeposition", PnZn 2020, San Diego, CA, February 24, 2020.

Funded Research Projects (Individual share- $4.8 million, Total - $7.5 million)

Principal Investigator since 2020

1. Laboratory Evaluation of Sustainable Suppressants (LESS), Amira Global, 2021-2022, $179,398, 50% share.
2. Ga, In and Ge Extraction from Zinc Residue produced from Steel Wastes, Critical Materials Institute, 2021-2022, $600,000 (S&T portion, $300,000).
3. Understanding Charge Effects on Marked Ball Wear Rates - A Corrosion Study, Molycop USA, 2021, $31,709.
4. Position Paper on Critical Element Recovery from the North American Copper Supply Chain, First Solar, 2020, $11,371, 40% share.
5. Anodes and Their Interaction with Thiourea on Slimes Generation, Deportment and Group 15 Elements and Cathode Deposits, Atlantic Copper, 2019-2020, $60,000.
6. Influences of Nickel, Copper and Total Sulfate in Electrolyte on Electrorefined Cathode Roughness and Quality, Sponsor Group, 2018-2022, $320,355, Corporate Sponsors: Atlantic Copper, Aurubis, LS-Nikko, New Boliden, Rio Tinto Kennecott Utah Copper. Research Partner: Laurentian University.
7. **Cost, Productivity and Occupational Health Improvements for Base Metal Electrowinning P705D, Project Leader and Researcher, AMIRA, 2018-2021, $888,000** (S&T portion, $452,243), Corporate Sponsors: De Nora Industrie, Freeport McMoRan, Nexa Resources, Umicore, Newmont. Research Partners: Laurentian University, Universidade Federal de Minas Gerais.

Co-P.I. since 2020

8. Improved Recovery of Tellurium and Associated Copper and Precious Metals during Processing of Copper Porphyry Deposits at Copperton Concentrator, First Solar, 2021-2023, $259,160. 10% share
9. WORKSHOP: Resilient Supply of Critical Minerals; Rolla, MO; May 2020, NSF, 2020, $49,886, 15%
10. Resource Evaluation and Technology Development, First Solar, 2020, $4,678, 20% share
11. Suppression of Exchange Reactions between Mold Fluxes and Steels Containing Reactive Elements and their Influence on Flux Crystallization, PSMRC, 2019-2022, $181,000, 30% share

Service

Professional Service

1. Society of Mining, Metallurgy and Exploration Inc., AIME, Member
   a. Society Level
      Audit Committee 2018-2021
      Strategic Nominating Committee, 2018-2020
      Structural and Governance Strategic Committee, 2018-
        Board of Directors Internship Development Ad Hoc Committee, Chair, 2019
      Education Sustainability Committee, 2013-2019
      Academic Grant Selection Committee, 2015-2018
        Chair 2017-2018
        Vice Chair 2016-2017
      Distinguished Member Award Nominating Committee, 2016-2017
      Robert E Murray Innovation Award Committee 2020-2021
   b. Associate Editor – Mining, Metallurgy & Exploration (MME), 2018-2019
   c. Mineral and Metallurgical Processing Division
      Lead Chair for Extraction 2025; Co-Chair for Copper 2025
      Co-chair Electrowinning/Electrorefining Symposium – Copper 2019
      Lead Organizer for Extraction 2018
      Executive Committee, 2012-2019 with many positions
      Separation Unit, Chair, 2011-2013
      James Douglas Gold Medal Award Committee, 2016-2017, 2018-2019
      Milton E. Wadsworth Award Committee, 2009-2012, 2020-2023
      Representative to International Organizing Committee for world Copper meetings, 2020-
2. TMS, AIME, Life Member
      TMS Representative for Copper 2013, Copper 2016
      Co-Organizer Electrometallurgy 2016 and 2024
3. Copper Refinery Group Coordinator, 2007-