

Dr. Michael L. Free

Professor

Metallurgical Engineering, 135 S. 1460 E. Rm 412,
University of Utah, Salt Lake City, Utah 84112
ph.: (801) 585-9798 fax: (801) 581-4937 E-mail: michael.free@utah.edu

Education:

1994 Ph.D., Metallurgical Engineering, Univ. of Utah
1992 M.S., Chemical Engineering, Univ. of Utah
1990 B.S., Metallurgical Engineering, Univ. of Utah

Related Work Experience:

2008-present Professor, Dept. of Metallurgical Eng., Univ. of Utah
(teaching, research in chemical metallurgy, corrosion, electrometallurgy)
2002-08 Associate Professor, Dept. of Metallurgical Eng., Univ. of Utah
(teaching, research in chemical and electrometallurgy)
1996-02 Assistant Professor, Dept. of Metallurgical Eng., Univ. of Utah
(teaching, research in chemical and electrometallurgy)
1995-96 Post-Doctoral Assoc., Dept. of Chemical Eng., Univ. of Florida
(apply/develop silicon wafer cleaning technologies)
1994-95 Post-Doctoral Assoc., Dept. of Materials Science & Eng, Univ. of Florida
(applied/developed filtration and modified crystallization technologies)
1992-94 Research Assistant, Dept. of Metallurgical Eng., Univ. of Utah
(applied/developed solution chemistry, interfacial phenomena)
1990-92 Research Assistant, Dept. of Chemical Eng., Univ. of Utah
(applied/developed biooxidation, and solution chemistry technologies)
1990 Lab Technician, Adv. Proc. Techn./Intern. Resin Res. (resin extraction)
1987-89 Lab Technician, Newmont Metallurgical Services (gold extraction)

Teaching Experience:

MET E 1050, Metals and Civilization, Univ. of Utah
MET E 1610, Introduction to Extractive Metallurgy, Univ. of Utah
MET E 1630, Introduction to Metallurgical Engineering I, Univ. of Utah
MET E 166, Introduction to Metallurgical Engineering, Univ. of Utah
MET E 3015, Global Influence of Metals, Univ. of Utah
MET E 3620, Thermodynamics, Univ. of Utah
MET E 5210/6210, Nuclear Materials, Univ. of Utah (team instructor)
MET E 5290/6290, Nanoscience and Technology, Univ. of Utah (team instructor)
MET E 5600/6600, Corrosion Fundamentals, Univ. of Utah
MET E 5700/6700, Low Temperature Chemical Processing (Hydrometallurgy), U.of U.
MET E 5760/6760, Process, Synthesis, Design, and Economics, U. of U.
MET E 5770/6770/7910, Electrometallurgy/Advanced Electrometallurgy, Univ. of Utah

MET E 5910, Surface Coating Technology, Univ. of Utah (team instructor)
MET E 6970 Master's Degree Thesis Research
MET E 7970 Doctor of Philosophy Degree Thesis Research

Overall Teaching Composite Average Student Evaluation Score: 5.51/6.00 (2012-2018)
Average Course Teaching Load (not incl. thesis research): 9.6 semester hrs/yr (2012-2018)

Professional Society Memberships:

The Minerals, Metals, and Materials Society (TMS)
Electrochemical Society (ECS)
Society of Mining, Metallurgy, and Exploration (SME)
National Association of Corrosion Engineers (NACE)
American Society for Engineering Education (ASEE)

Awards/Recognition:

2020 TMS EPD Distinguished Service Award
2017 Gaosong Yi, a member of Michael L. Free's research group, was the
ASM International Student Paper Contest Winner
2017 University of Utah Career Services Faculty Recognition Award
2017 Gaosong Yi, a member of Michael L. Free's research group, received the
Heat Treatment Society Best Paper in Heat Treating Award
2017 Gaosong Yi, a member of Michael L. Free's research group, was awarded
2017 NACE Graduate Student Book Award
2016 Joshua Werner, a member of Michael L. Free's research group, was
selected as a Henry Krumb Lecturer for 2017
2016 Keynote Speaker – Electrometallurgy 2016 International Conference
2015 Yakun Zhu, a member of Michael L. Free's research group, was awarded
2015 NACE Graduate Student Book Award
2015 Yakun Zhu, a member of Michael L. Free's research group, received one
of 500 Chinese students to receive the “2015 National Award for
Outstanding Self-financed Chinese Students Study Abroad”
2015 Joshua Werner, a member of Michael L. Free's research group, received an
SME Graduate Fellowship (the only one in his area of research in 2015)
2015 Our group's paper “Demonstrated Utility of By-Product Quantum Dots
Obtained during Synthesis of $\text{Cu}_2\text{ZnSnS}_4$ Colloidal Ink (Ceramics
International, ~ 12600 downloads – became a top 50 article of the decade
in the materials area within Elsevier journals)
2015 Plenary Speaker –International Conference on Lean Grade and Urban Ores
2014 Plenary Speaker - International Minerals Engineering Congress
2014 Plenary Speaker – Shechtman International Symposium
2013 Keynote Speaker – International Soc. of Electrochemistry Annual Meeting
2012 Invited Speaker - Encuentro Internacional Metalurgia Peru 2012

- 2012 Top 10 paper download Physica B (Nov 2011-Feb 2012)
- 2012 Top 15 paper download Thin Solid Films (Nov 2011-Feb 2012)
- 2011 Top 3 paper download Physica Status Solidi A (Dec 2011)
- 2011 Top 20 paper download Physica Status Solidi B (2011)
- 2011 Keynote Speaker – Derick Fray International Symposium
- 2007 Liberati Award (top 4 paper in Anti-Corrosion Methods and Materials)
- 2001 Outstanding Faculty Teaching Award, Met. Eng. Dept.
- 2000 Young Leader, TMS
- 2000 National Science Foundation (NSF) CAREER Award
- 1998 Outstanding Faculty Teaching Award, Met. Eng. Dept.
- 1994 Teaching Assistant of the Year, College of Mines and Earth Sciences
- 1994 Teaching Assistant of the Year, Met. Eng. Dept.
- 1994 Graduate Seminar Presenter of the Year, Met. Eng. Dept.
- 1989 Chevron Scholarship, Univ. of Utah
- 1988 Metallurgical Eng. Dept. Scholarship, Univ. of Utah
- 1984 Honors at Entrance Scholarship, Univ. of Utah

Leadership:

- 2020- TMS appointed member, North American Extractive Metallurgy Council
- 2020- Chair SME Taggart Award Committee
- 2019- Chair of Department of Mining Engineering
- 2019- Co-organizer for Electrometallurgy 2024
- 2019- Co-organizer for Hydrometallurgy 2023
- 2018- Co-organizer for 2020 Electrometallurgy Symposium
- 2018- TMS EPD – Senior Advisor
- 2017-19 Deputy Node Leader for Recycling and Recovery, REMADE Institute (\$140 million DOE-funded clean manufacturing institute)
- 2016-18 Head organizer, Hydrometallurgy 2018 Symposium
- 2015-17 Chair of Department Faculty Relations Committee
- 2013-17 Associate Chair, Department of Metallurgical Engineering
(led the development of a new curriculum, led the UofUs involvement in The REMADE Institute, which led to more than \$1.4 million in funding)
- 2015-17 Co-organizer for 2017 Ramana Reddy Symposium
- 2015-16 Co-organizer for 2016 Electrometallurgy Symposium
- 2014 Chair of College Faculty Relations Committee
- 2011 Head Organizer & Originator of TMS/CIM “Electrometallurgy” Symposia
- 2011 Co-organizer for 2012 T. T. Chen Symposium
- 2011 Vice-Chair, SME Accreditation and Education Committee
- 2011-12 Programming Representative, EPD Executive Committee (TMS)
- 2010 Chair of College Faculty Relations Committee
- 2010 Chair of SME Taggart Award Committee
- 2010 Chair of College Computer Committee
- 2009-11 Chair of TMS Hydrometallurgy and Electrometallurgy Committee

2007 Vice-chair of TMS Aqueous Processing Committee
 2006 Chair of University of Utah Financial Aid & Scholarships Committee
 2006 Co-organizer of TMS 2007 Innovations in Electrometallurgy Symposium
 2005-07 Member of University of Utah Financial Aid & Scholarships Committee
 2005 Co-organizer of Jan D. Miller International Symposium (SME)
 2005-07 Programming Representative, EPD Executive Committee (TMS)
 2002-01 Chair of College Computer Committee
 2000 Vice Chair of Local SME Section
 2001 College of Science Day Coordinator for College of Mines and Earth Sciences
 1999 College of Science Day Coordinator for College of Mines and Earth Sciences
 1999 Co-chair MPD Hydrometallurgical Processing Committee,
 1998-01 Treasurer of Local ASM International Chapter
 1998-99 2nd Vice Chair of Local SME Section
 1992-93 Chairman of Metallurgical Engineering Dept. Student Advisory Committee
 1989-90 Member of Univ. of Utah Student Government ASUU Executive Committee
 1989-90 ASUU Student Government Rep. for the College of Mines & Earth Sciences
 1989-90 Vice-Chairman of Univ. of Utah Student Gov. ASUU Appropriations Com.

Service:

Strategic Advisory Committee Member, REMADE Institute, 2018-19
 Global Change and Sustainability Center Executive Committee Member 2018-2019
 Member of University of Utah Nanofab Faculty Executive Committee (2017-18)
 Member of Editorial Board of the Journal "Metals" (2017-)
 Member SME Taggart Award Committee (2017-)
 Member of College Executive Committee (2016-17, 2019-)
 Member of College Accreditation Committee (2016-)
 Member of College ABET Committee (2016-)
 Member of College Space Committee (2016-2017)
 Member of Department RPT Committee (2012-)
 Member of Editorial Advisory Board for Anti-Corrosion Methods and Materials (2004-)
 Session or co-chair for many professional society presentation sessions (1997-)
 Member of TMS Hydrometallurgy/Electrometallurgy Committee (2007-)
 Reviewer for various journals and organizations (1997-)
 (Journal of the Electrochemical Society, Electrochimica Acta, Colloids and Surfaces A, Mineral and Metallurgical Transactions, and Mineral and Metallurgical Processing, Industrial and Engineering Chemistry Research, In – Situ, Journal of Adhesion Science and Technology, Applied Surface Science, Corrosion Science, Metallurgical Transactions B, National Science Foundation, Hydrometallurgy, Chemical Engineering Communications, Environmental Science and Technology, International Journal of Refractory Metals and Hard Materials, Journal of Materials Science, Materials Science and Engineering A, Scripta Materialia, Corrosion Engineering Science and Technology, Journal of

Mining and Metallurgy+ several conference proceedings. (Top 10 reviewer for Scripta Materialia))

Department Outreach Activities (1996-)

50+ presentations in local school classes

20+ presentations to high school groups at annual College of Science Day participation multiple times in Department Open Houses, Plaza Fest, Major Day on campus organized and taught seven corrosion workshops for high school students; produced high-quality materials for student recruitment on the high school and community college level; established a pre-metallurgical engineering associate degree at Salt Lake Community College with help from program advisors there.

Member of IMPC 2016 Technical Program Committee (2015-2016)

Member of University of Utah Academic Senate (2014)

TMS Extraction and Proc. Division Programming Representative (2011-2014)

Member of University of Utah Salaries and Annuities Committee (2011-2014)

Member of College Safety Committee (2010-2013)

Member of College Computer Committee (2010-2013)

Department Undergraduate Advisor (1997 – 2012)

Member of University of Utah Nanofab Executive Committee (2008-2012)

Member of TMS Public Relations Committee (2008-2011)

Member of Univ. of Utah RPT Standards Committee (2008-2011)

Member of College Faculty Relations Committee (2009-2011)

Member of Univ. of Utah Rev. Promot. & Tenure Standards Com. (2008-2011)

Member of College Curriculum Committee (2006-2010)

Member of SME Taggart Award Committee (2007-2010)

TMS Extraction and Proc. Division Programming Representative (2005-2008)

Member University of Utah Personnel and Elections Committee (2005-2008)

Member of Univ. of Utah Scholarship and Financial Aid Committee (2004-2007)

Elected to University of Utah Academic Senate (2004-2007)

Member of University of Utah Financial Aid and Scholarships Com. (2004-2007)

Member of College Faculty Promotion and Tenure Committee (2003-2005)

Member of University of Utah Communications/Writing Committee (2002-2005)

Member of Board of Review of Metallurgical and Materials Transactions B 2000-2005.

Elected to University of Utah Undergraduate Council (2001-2004)

Member of College Computer Committee (2001-2003)

Member of University of Utah Credits and Admissions Committee (1998-2002)

Guest editor for Journal of Metals (2001)

Member of Scientific and Technical Programming Committee SIS-2000

Member of Garr-Cutler Energy Awards Committee (1997-2000)

Reviewer for University of Utah programs (various)

Member of thesis/dissertation committees for the following graduate students:

Gustavo Munoz-Rivadeneira (M. S.)

Qiang Liu (Ph. D.)
Christopher E. Milliken (Ph. D.)
Michael R. Loveless (Ph. D.)
Dong Hoon Han (Ph. D.)
Jinshan Li (M. E.)
Xuming Wang (M. S.)
Byung Su Kim (Ph.D)
Mehmet Hancer (Ph. D)
Parijat Bhatnagar (M. S. – advisor)
Marcin Niewiadomski (M. S.)
Paul Nolan Clark (Ph. D., Mechanical Engineering)
Mehmet Tarakci (Ph. D.)
Byung Sang Choi (M. S.)
Firdosh Kavarana (M. S.)
Krutibas Panda (M. S.)
Sushant Jha (Ph. D)
Minhua Li (M. S.)
Shampa Aich (M. S.)
Kevin Ngyen (M. S.)
Lei Chen (M. S. – advisor)
Gilsoo Han (Ph. D.)
Manish Sharma (M. S. – advisor)
Wanlin Wang (M. S. – advisor)
Gustavo Munoz (Ph. D.)
Sylwia Wisniewska (Ph. D.)
Keqing Fa (Ph. D.)
Christian Roldan (M. S.)
Vamsi Paruchuri (Ph. D.)
Francisco Medina (M. S.)
Ravindra Bhide (M. S. – advisor)
Ben Dibble (Ph. D., Chemistry)
Xuming Wang (Ph. D.)
Kimberli Jones (Ph. D., Mechanical Engineering)
Pinai Mungsantisuk (Ph. D.)
Andrew Wessman (M. S. - advisor)
Dong Y. Ryu (Ph. D. - advisor)
Marcin Niewiadomski (Ph. D.)
Jinshan Li (Ph. D.)
Robert Corson (Ph. D.)
Ravindra Bhide (Ph. D. - advisor)
Peng Fan (Ph. D.)
Bartosz Dubrowski (M. S.)
Krutibas Panda, (Ph. D.)
Aphichart Rhodchanarowan (Ph. D. – advisor)

P. Kumar (M. S.)
Amit Jain (M. S.)
Nikit Phadke (M. S. – advisor)
Mike Oja (M. S.)
Lucas Hupka (M. S.)
Moo-Eob Choi (M. S.)
Edgar Blanco (M. S.)
Jei-Pil Wang (M. S.)
Nishant Tikekar (Ph. D.)
Jennie Schreffler (M. S., Chemistry)
Hao Du (Ph. D.)
Orhan Ozdemir (Ph. D.)
Tanjore Jayaraman (Ph. D.)
Laura Parke (M.S., Chemistry)
James Wright (Ph. D., Materials Science and Eng.)
Sravan Kumar Prathy (M. S.)
Prachi Shrivastava (M. S.)
Shamita Shitole (M. S. – advisor)
Prashant Saraswat (M. S. – advisor)
Soumya Kar (Ph. D. – advisor)
Swieng Thuanboon (Ph. D.)
Adirek Janwong (M. S.)
Sung Sil Park (M. S.)
Taegong Ryu(Ph. D.)
Nathan Warner (M. S. - advisor)
Chayata Piriyapong (M. S.)
Jei-Pil Wang (Ph. D.)
Nurzhan Dyussekenov (M. S.)
Vishal Gupta (Ph. D.)
Thien Vethosodkda (M. S. – advisor)
Youness Kouraibchia (M. S.)
Aleksandra Opara (M. S.)
Liangzhu Zhu ()
Dan Darlington (M. S. – advisor)
Mark Robison (M. S. – advisor)
Yakun Zhu (M. S. – advisor)
Prashant Saraswat (Ph. D. – advisor)
Prashant Bagri (M. S.)
Nikhil Dhawan (Ph. D.)
Roger Flinders (Ph. D., Materials science)
Robert Hackendorn (Ph. D., Materials science)
Adirek Janwong (Ph. D.)
Christopher Kareis (Ph. D. Chemistry)
Sandro Marino (M. S.)

Meeknashisundaran Ramanathan (Ph. D.)
Chai Ren (Ph. D.)
Sadegh Safarzadeh (Ph. D.)
JiaJia Tan (M. S., Materials Science)
Xihui Yin (Ph. D.)
Biplap Sarma (Ph. D.)
Yizhao Lang (M. S., materials science)
Abhijeet Shukla (M. S. – advisor)
Aleksandra Opara (Ph. D. – advisor)
Bo Pan (M. S.)
JiaJia Tan (Ph. D., Materials Science)
Amy Chambers (M.S. – advisor)
Gaosong Yi (Ph. D. – advisor)
Tyler Helsten (M. S.)
Weizhi Zeng (Ph. D. – advisor)
Jiaqi Jin (Ph. D.)
Bo Liu (Ph. D.)
Zhixue Chris Yuan (M. S.)
Dhiman Bhattacharyya (M. S.)
Madhusudan Jagannathan (Ph. D.)
York Smith (Ph. D.)
Jason Neff (M. S.)
Xia Zhang (Ph. D.)
Alexander Derrick (M. S. – advisor)
Dhiman Bhattacharyya (M. S.)
Roger Flinders (Ph. D. –materials science)
Abraham Jurovitzki (M. S.)
Jing Liu (Ph. D.)
Oscar Wheeler (Ph. D. Chemistry)
Xiangyi Luo (Ph. D.)
Silvia Perez-Fontes (Ph. D.)
York Smith (Ph. D.)
Zuoxing Wang (M. S.)
Oscar Wheeler (Ph. D.)
Devin Rappleeye (Ph. D.)
Jae-Hun Cho (M. S. - advisor)
Syamantak Roy (M. S. - advisor)
Joshua Werner (Ph. D. – advisor)
Brandon Anglesey (M. S. – advisor)
Sayan Sarkar (Ph. D. – advisor)
Erik Sundberg (M. S. – advisor)
Dhiman Bhattacharyya (M. S.)
Amr R. A. Mohamed (Ph. D.)
Javed Akram (Ph. D.)

Prashant Bagri (Ph. D.)
Adam Burak (Ph. D.)
Mohamed Elzohiery (Ph. D.)
Dequi Fan (Ph. D.)
Bhaskar Vadlamani (Ph. D.)
Zongliang Zhang (Ph. D. – advisor)
Joshua Greene (M. S. – advisor)
Matthew Lemieux (Ph. D. Chemical Engineering)
Sugandha Sharma (M. S.)
Milan Stika (Ph. D.)
Yuxuan Zhang (Ph. D.)
Shannon Adams (M. S.)
Jake Graser (Ph. D. – Materials Science & Eng.)
David Horvath (Ph. D.)
Zhe Huang (M. S.)
Rahul Sarkar (Ph. D.)
Kaustubh Shrimali (Ph. D.)
Behzad Hassas (M.S.)
Vu Truong (Ph. D.)
Maryam Ghiasee (Ph. D. Chemistry)
Yang Fan (Ph. D. Chemistry)
Landon Allen (M. S – advisor)
Arun Murali (Ph. D. – advisor)
Alexander Hesketh (M. S. – advisor)
Taylor Smith (M.S. – advisor)
Prasenjit Podder (M.S. – advisor)
Nora Alnajjar (M. S.)
Venkata Atluri (Ph. D.)
Denver Cowan (Ph. D., Queens University, Canada, Mining Eng.)
Maryam Ghasee (Ph. D. Chemistry)
Jake Graser (Ph. D. – Materials Science and Eng.)
Jeff Palmer (M. S.)
Haruka Pinegar (Ph. D.)
Juli Sundberg (Ph. D. – Chemistry)
Fan Yang (Ph. D. – Chemistry)
Chao Zhang (Ph. D.)
Petrus J van Staden (Ph. D. Univ. Cape Town, South Africa, Chem. Eng.)
Archana Kumari (Ph. D. – Indian School of Mines, IIT Dhanbad, India)
Tuoyang Zhang (Ph. D.)
Joel Illunga (M. S. – advisor)
Nora Alnajjar (Ph. D.)
Rajashekhar Marthi (Ph. D.)
Aaron Young (Ph. D. Mining Engineering)

Undergraduate Students Employed and Mentored:

George Forgey
Katherine Hurst
Kevin Petersen
Thao Huang
Justin Fuller
Eric Riddle
Rebecca Cook Chandler
David Tibbits
Michael Gonzales
Cameron Barton
Merrill Tayler
James Paramore
Taylor Bird
Scott Middlemas
Eric Anderson
Alysha Comstock
Ryan Morrison
Justin McCallister
Abraham Jurowitski
Megan Marshall
Urian (Bud) Marshall
Lauryn Hansen
Brandon Anglesey
Nathan Hamilton
Daniel Azbill
Jaron Wallace
Colton Allred
Chimediyudon Tsogdelger
Steven Evans
Jaxon Roller
Kevin Colburn
Wyatt McNeil
Sylvia Padilla Mendez
Chris Sanderson
Marina McNeil
Jayson Benedict
Errol Kurtz
Alexander Hesketh
Kara Sorenson
Kitsel Lusted

High School Students Employed and Mentored:

Samantha Lawrence
Ben Pound
Julie Vogel

Visiting Scholars Supervised and Mentored:

Dr. Muhammed Aboukashem
Dr. Baoping Zhang
Dr. Yaowei Li
Dr. Ning Liu
Dr. Ruixiang Wang
Dr. Xianwei Hu
Wei Liu (Ph. D. candidate)

Post-doctoral Associates Employed and Mentored:

Dr. Amarchand Sathyapalan
Dr. Prashant Sarswat
Dr. Soumya Kar
Dr. Francis Elnathan

Research Professors Employed and Mentored:

Dr. Amarchand Sathyapalan
Dr. Prashant Sarswat

Publications: (253 total)

Books:

1. Michael L. Free, Chemical Processing and Utilization of Metals in Aqueous Media, XanEdu Original Works, pp. 1-256, 2003.
2. Michael L. Free, Chemical Processing and Utilization of Metals in Aqueous Media, 2nd Edition, XanEdu Original Works, pp. 1-331, 2004.
3. Michael L. Free, Hydrometallurgy Fundamentals and Applications, John Wiley and Sons, Inc., Hoboken, New Jersey, pp. 1-444, 2013. (> 700 copies sold)

Edited Books:

1. Innovations In Natural Resource Processing: Proceedings of the Jan D. Miller Symposium, Ed. Courtney A. Young, J. J. Kellar, Michael L. Free, Jaroslaw Drelich, R. P. King, SME, Littleton, 2005.

2. EPD Congress 2006, TMS, Warrendale, Ed. S. Howard, R.L. Stephens, C.J. Newman, J-Y.J. Hwang, A.M. Gokhale, T.T. Chen, T.P. Battle, M.L. Free, B.R. Davis, C.L. Harris, H. Henein, P.N. Anyalebechi, A.C. Powell, G.K. Krumdick and C.K. Belt, 2006.
3. EPD Congress 2010: Extraction and Processing Division, TMS, Warrendale, Edgar E. Vidal (Editor), Ann M. Hagni (Section Editor), Michael L. Free (Section Editor), Prince N. Anyalebechi (Section Editor), Joseph Pomykala (Section Editor), Christina E. M. Meskers (Section Editor), 2010.
4. "Electrometallurgy – Now and in the Future," Proceedings of Electrometallurgy 2012 Symposium, Ed. M. L. Free, M. S. Moats, G. Houlachi, E. Asselin, A. Allamore, J. Yurko, S. Wang, TMS, Warrendale, 2012.
5. "Proceedings of the T. T. Chen Symposium," Ed. S. Wang, J. E. Dutrizac, M. L. Free, J. Y. Hwang, D. Kim, TMS, Warrendale, 2012.
6. "EPD Congress 2013," Ed. M. L. Free, A. H. Siegmund, TMS, Warrendale, 2013.
7. "Electrometallurgy 2016," Ed. G. Houlachi, M. L. Free, M. Agnew, M. S. Moats, F. Mohammadi, E. Asselin, C. Brown, E. Guerra, A. Ghahremaninezhad, S. Wang, 2016.
8. "Applications of Process Engineering Principles in materials Processing, Energy and Environmental Technologies, An EPD Symposium in Honor of Professor Ramana G. Reddy," Ed. Shijie. Wang, Michael. L. Free, Shafiq Alam, Mingming Zhang, Patrick R. Taylor, Springer, Cham, Switzerland, 2017.
9. Proceedings of Extraction 2018, TMS, ed. Boyd R. Davis, Michael S. Moats, Shijie Wang, Dean Gregurek, Joël Kapusta, Thomas P. Battle, Mark E. Schlesinger, Gerardo Raul Alvear Flores, Evgueni Jak, Graeme Goodall, Michael L. Free, Edouard Asselin, Alexandre Chagnes, David Dreisinger, Matthew Jeffrey, Jaeheon Lee, Graeme Miller, Jochen Petersen, Virginia S. T. Ciminelli, Qian Xu, Ronald Molnar, Jeff Adams, Wenying Liu, Niels Verbaan, John Goode, Ian M. London, Gisele Azimi, Alex Forstner, Ronel Kappes, Tarun Bhambhani, 2018.

Chapters in Books

1. M. L. Free, D. O. Shah, "The Role of Surfactant in Reducing Adhesion Forces Between Alumina Particles and Quartz Surfaces", in Particles on Surfaces 5&6: Detection, Adhesion, and Removal, ed. K. L. Mittal, VSP International Science Publications, 95-106, 1999. (peer-reviewed)

2. M. L. Free, D. O. Shah, “Enhancement of Particle Removal and Modification of Interfacial Phenomena Using Surfactants”, in Particles on Surfaces 7: Detection, Adhesion, and Removal, ed. K. Mittal, VSP, Utrecht, de Netherlands, pp. 405-418, 2002. (peer-reviewed)
3. M. L. Free, “The Use of Surfactants to Reduce Particulate Contamination on Surfaces,” in Particles on Surfaces 8: Detection, Adhesion, and Removal, ed. K. Mittal, VSP, Utrecht, de Netherlands, pp. 129-139, 2003. (peer-reviewed)
4. M. L. Free, “Prediction of Particle Removal Using Surfactants,” in Particles on Surfaces 9: Detection, Adhesion, and Removal, ed. K. Mittal, VSP, Utrecht, de Netherlands, pp. 317-328, 2006.
5. M. L. Free, “The Use of Surfactants in Enhancing Particle Removal,” invited chapter (14) in Developments in Surface Contamination and Cleaning, edited by R. Kohli and K. L. Mittal, William Andrew, Norwich, pp. 727-758, 2007.
6. M. L. Free, “The Use of Surfactants to Enhance Particle Removal from Surfaces,” invited chapter (14) in Developments in Surface Contamination and Cleaning, ed. Rajiv Kohli and K. L. Mittal, William Andrew Inc., 727-758, 2008.
7. M. L. Free, “Introduction to Surfactants,” invited chapter (1) in Surfactants in Tribology, edited by G. Biresaw and K. Mittal, Taylor and Francis Group, New York, pp. 3-10, 2008.
8. Michael L. Free, Biohydrometallurgy, Chapter 2.8 in Treatise of Process Metallurgy, Vol. 3, ed. Seshadri Seetharaman, Elsevier, Oxford, UK, 983-994, 2014.
9. Michael L. Free and Michael S. Moats, Hydrometallurgical Processing, Chapter 2.7 in Treatise of Process Metallurgy, Vol. 3, ed. Seshadri Seetharaman, Elsevier, Oxford, UK, 949-982, 2014.
10. Prashant K Sarswat, Amarchand Sathyapalan, Michael L. Free, Current trends in molecular functional monolayers, invited chapter (13) in Anti-Abrasive Nanocoatings: Current and Future Applications, ed. Mahmood Aliofkhaezai, Woodhead Publishing Limited, pp. 331-348, 2015.
11. Michael L. Free “The Use of Surfactants to Enhance Particle Removal from Surfaces,” Chapter 13 in Volume 1: Developments in Surface Contamination and Cleaning, 2nd edition, ed. Rajiv Kohli and K. L. Mittal, Elsevier, pp. 595-626, 2016.
12. Michael S. Moats and Michael L. Free, Electrowinning, SME Mineral Processing and Extractive Metallurgy Handbook, SME, Littleton, Chapter 10.16, 1368-1390, 2019.
13. Michael S. Moats and Michael L. Free, Electrorefining, SME Mineral Processing and Extractive Metallurgy Handbook, SME, Littleton, Chapter 10.17, 1391-1410, 2019.

Journal Publications

1. M. L. Free, J. D. Miller, "The Effect of Sample Area in Quantitative Spectroscopy", *Applied Spectroscopy*, 48(7), 891-893, 1994.
2. M. L. Free, W. H. Jang, J. D. Miller, "Quantitative Fourier Transform-Infrared Internal Reflection Spectroscopy (FT-IR/IRS) for Adsorption Density Measurements," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 93,127-135, 1994.
3. M. L. Free, J. D. Miller, "The Significance of Collector Colloid Adsorption Phenomena in the Fluorite/Oleate System," *International Journal of Mineral Processing*, 48, 197-216, 1996.
4. S. Y. Shiao, A. Patist, M. L. Free, V. Chhabra, P. D. T. Huibers, A. Gregory, S. Patel, and D. O. Shah, "The Importance of Sub-Angstrom Distances in Mixed Surfactant Systems for Technological Processes," *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, 128, 197-208, 1997.
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2. “Bioleaching of Sulfide Ores - Distinguishing Between Indirect and Direct Mechanisms”
Mineral Bioprocessing Conference, Santa Barbara, California, June 16-22, 1991.

3. “Bioleaching of a Sulfide Ore-Concentrate - Distinguishing Between the Leaching Mechanisms of Attached and Nonattached Bacteria”, Chemical Engineering Department Seminar, Salt Lake City, Utah, February, 1992.

4. “A Comparison of Leaching by Attached and Nonattached Bacteria of a Pyrite/Arsenopyrite Gold-Ore Concentrate,” Presented at the 1993 International Biohydrometallurgy Symposium, Jackson, Wyoming, August 22-25.

5. “The Effect of Isopropyl Xanthate on the Bioleaching of a Pyrite-Arsenopyrite Ore Concentrate,” Poster Presentation with Soumitro Nagpal at the 1993 International Biohydrometallurgy Symposium, Jackson, Wyoming, August 22-25.

6. “Quantitative Fourier Transform-Infrared Internal Reflection Spectroscopy (FT-IR/IRS) for Adsorption Density Measurements,” Poster presentation with Woo-Hyuk Jang at the 1994 Symposium on “Surface Characterization of Adsorption/Interfacial Reactions”, Kona, Hawaii Jan 9-14, 1994.

7. “Adsorption Phenomena in the Fluorite/Oleate System”, Metallurgical Engineering Seminar, Salt Lake City, Utah, Presented May 4, 1994.

8. “The Role of Calcium in Fluorite/Oleate Flotation System,” presented at the SME Annual Meeting, Denver, Colorado, March 6-9, 1995.

9. “Biooxidation of Refractory Gold Ore Concentrate: Understanding the Role of Bacteria,” Department of Metallurgical Engineering, Salt Lake City, Utah, June 14, 1996.

10. “The Role of Surfactant in Reducing Adhesion Forces Between Alumina Particles and Quartz Surfaces,” 27th Annual Meeting of the Fine Particle Society, Chicago, Illinois,

August 6-7, 1996.

11. "Particle Adhesion Phenomena in the Cleaning of Silicon Wafers," 20th Annual Meeting of the Adhesion Society, Hilton Head Island, South Carolina, Feb 23-26, 1997.
12. "Precious Metal Hydrometallurgy", Pontificia Universidad Catolica del Peru, Lima, Peru, November 5, 1997
13. "Gold Hydrometallurgy," Pontificia Universidad Catolica del Peru, Lima, Peru, Nov. 6, 1997
14. "The Use of Organic Reagents in Modifying Crystallization Processes and Enhancing Phosphogypsum Filtration," University of Utah, Salt Lake City, Utah, May 28, 1997.
15. "The Use of Organic Reagents in Modifying Crystallization Processes and Enhancing Phosphogypsum Filtration," J. R. Simplot Co., Pocatello, Idaho, June 25, 1997.
16. "New Horizons in Surfactant Applications", University of Florida, Gainesville, Florida, March 11, 1998.
17. "Exploring Important Effects of Surfactants in Metallurgical Engineering", University of Idaho, Moscow, Idaho, March 25, 1998.
18. "The Effect of Anode Impurities on Copper Electrorefining," Preprint - SME 2000 Annual Meeting, Salt Lake City, Utah, March 1, 2000.
19. "Enhancement of Particle Removal and Modification of Interfacial Phenomena Using Surfactants" Seventh International Symposium on Particles on Surfaces: Detection, Adhesion, and Removal, June 21, 2000, Newark, New Jersey.
20. "Using Surfactants to Enhance Particle Removal from Metal Surfaces – Department of Metallurgical Engineering Graduate Seminar, September 6, 2000, Salt Lake City, Utah.
21. "The Use of Surfactants and Cosurfactants in Corrosion Inhibition – TMS Annual Meeting, February 15, 2001, New Orleans, Louisiana.
22. "Pulse-Plating of Zinc-Nickel Alloy Metal Matrix Composite Coatings - TMS Annual Meeting, February 14, 2001, New Orleans, Louisiana.
23. "Electrochemical Coupling of Metal Extraction and Electrowinning – Electrometallurgy 2001, August 25, 2001, Toronto, Canada.
24. "The Effect of Surfactant and Environment Parameters on Mild Steel Corrosion Inhibition, TMS Annual Meeting, February 18, 2002.

25. Utilization of Surface Forces and Transport Phenomena in Predicting Particle Incorporation in Electrodeposited Metal Matrix Composites, TMS Annual Meeting, February 19, 2002.
26. Teaching Corrosion via the Internet Using a Variety of Tools to Enhance Learning, TMS Annual Meeting, February 21, 2002.
27. The Use of Surfactants to Enhance Particle Removal from Surfaces, Eighth International Symposium on Particles on Surfaces: Detection, Adhesion, and Removal, Providence, Rhode Island, June 25, 2002.
28. Understanding and Using Surfactants to Enhance Particle Removal During Post CPM-Cleaning, IBM, East Fishkill, New York, June 26, 2002.
29. The Application of Equations to Predict Corrosion Inhibition in Aqueous Media Based Upon Surfactant Properties and Solution Ionic Strength, United Technologies Research Center, East Hartford, Connecticut, June 26, 2002.
30. Incorporation of Particles in Metal Matrix Composite Coatings Using Pulsed Electrodeposition, SME Annual Meeting, Cincinnati, February 27, 2003.
31. The Application of Equations to Predict Corrosion Inhibition in Aqueous Media Based Upon Surfactant Properties and Solution Ionic Strength, NACE International Annual Meeting, San Diego, March 20, 2003.
32. Electrochemical Reaction Rate Modeling: Incorporating the Effects of Surfactant, Solution, and Mass Transport Parameters, United Technologies Research Center, East Hartford, Connecticut, September 10, 2003.
33. Prediction of Chemical Removal Rates During CMP Processes in the Presence of Surfactant as a Function of Chemical Environment, Surfactant Chain Length, and Surfactant Functional Group Parameters, ACS Annual Meeting, New York, September 11, 2003.
34. Prediction of Post-CMP Particle Removal From Copper and Tungsten Surfaces in the Presence of Surfactant as a Function of Chemical Environment, Surfactant Chain Length, and Surfactant Functional Group Parameters, ACS Annual Meeting, New York, September 11, 2003.
35. Electrolytic Solution Purification and Metal Recovery from Toxic Waste Streams, CAST Annual Workshop, Charleston, West Virginia, November 21, 2003.
36. Electrochemical Modeling of Corrosion Inhibition Using Surfactants, TMS Annual Meeting, Charlotte, March 15, 2004.
37. Removal of Toxic Ions from Dilute Waste Streams by Novel Electrodeposition Techniques, TMS Annual Meeting, March 18, 2004.

38. Surfactant Adsorption on Particles, Millenium Inorganic Chemicals, Baltimore, Maryland, June 16, 2004.
39. Using Surfactant Adsorption Information to Predict Particle Removal, Ninth International Symposium on Particles on Surfaces: Detection, Adhesion, and Removal, Philadelphia, Pennsylvania, June 17, 2004.
40. Modeling the effectiveness of surfactants in sub-micron particle removal from solid substrates, TMS Annual Meeting, San Francisco, February 17, 2005.
41. Understanding the relationship between surfactant adsorption and metal corrosion inhibition, TMS Annual Meeting, San Francisco, February 17, 2005.
42. Improvements in the Leaching of Copper from Oxide Deposits, Phelps Dodge Mining Company, Safford, March 17, 2005.
43. Electrolytic Solution Purification and Metal Recovery from Toxic Waste Streams, CAST Workshop, Blacksburg, July 28, 2005.
44. Improving the morphology of copper electrodeposits from halide media using additives and mass transport control, Electrochemical Society Annual Meeting, Los Angeles, Oct 20, 2005
45. Mathematical Modeling and Experimental Validation of Steel and Copper Corrosion Based Upon Combined Thermodynamic, Electrochemical, and Mass Transport Fundamentals, Tri-Services Corrosion Conference, NACE, November 17, 2005.
46. The role of surfactant in chemical etching and particle removal associated with chemical mechanical planarization during integrated circuit manufacturing, Metallurgical Engineering Department, Salt Lake City, January 11, 2006
47. Corrosion, ASM-International Chapter Meeting, Salt Lake City, January 19, 2006.
48. Mathematical Modeling and Experimental Validation of Steel and Copper Corrosion Based Upon Combined Thermodynamic, Electrochemical, and Mass Transport Fundamentals, ARMY Corrosion Summit, Clearwater, February 15, 2006.
49. The Effect of Additives on Morphology of Copper Electrodeposits from Halide Media, TMS Annual Meeting, San Antonio, March 14, 2006.
50. The Effect of Mass Transport on Morphology of Copper Electrodeposits from Halide Media, TMS Annual Meeting, San Antonio, March 14, 2006.

51. Measurement and prediction of electrochemical removal of copper and subsequent sub-micron particle removal associated with chemical mechanical planarization in the presence of surfactants, SME Annual Meeting, March 29, 2006.
52. Evaluation of the effects of additives, pulsing, and temperature on morphology of copper electrodeposited from halide media, Electrochemical Society Meeting, Denver, May 10, 2006.
53. Metal Corrosion, Galvanic Coatings, and Mathematical Modeling, Army Research Lab, Aberdeen, August 17, 2006.
54. Electrochemical Modeling of Electrowinning Performance, TMS Sohn Symposium, San Diego, August 30, 2006.
55. Electrowinning Phenomena, Phelps Dodge Morenci Operations, Morenci, AZ, January 19, 2007.
56. Modeling Surface Roughness of Copper Electrodeposits from Chloride Media, "Electrochemical Society Meeting, Chicago, May 8, 2007.
57. Technologies to Reduce Energy Consumption for Copper Production from Chalcopyrite, Center for Advanced Separation Technologies, Blacksburg, VA, July 25, 2007.
58. Correcting for Scale-Up Phenomena, Copper 2007, Toronto, Canada, August 29, 2007.
59. The Future of Hydrometallurgy in NonFerrous Metal Production, New Technologies International Conference in NonFerrous metal Mineral Processing and Metallurgical Engineering, Liuzhou, China, November 23, 2007.
60. A Novel Method For Isolating Electrodeposited Films, PEAKS Symposium on Electrochemical Processes for Microelectronics, June 25, 2008, Kalispell, Montana
61. Effects of Mass Transport and Macromolecular Additives on Copper Electrodeposit Microroughness, PEAKS Symposium on Electrochemical Processes for Microelectronics, June 25, 2008, Kalispell, Montana
62. Integration of Chalcopyrite Ore Leaching, Solution Purification, and Electrowinning in Sodium Chloride Media, Hydrometallurgy 2008, Phoenix, August 19, 2008.
63. Evaluation of Ferric Ion Reductants in Sulfate Based Copper Electrowinning Electrolyte, Hydrometallurgy 2008, Phoenix, August 20, 2008.
64. Effects of Additives on copper electrodeposit roughness in chloride media, Hydrometallurgy 2008, Phoenix, August 20, 2008.

65. Measuring and Modeling Thermal Exposure Corrosion Damage Susceptibility of Aluminum 5xxx Alloys, Mechanical Engineering Department Seminar, February 27, 2009.
66. Understanding Acid Consumption in Heap Leaching, SME Annual Meeting, Phoenix, March 2, 2010.
67. Leaching Fundamentals, Votorantim, Belo Horizonte, Brazil, May 11, 2010.
68. Predicting the effects of locked, partially locked, and liberated valuable mineral grains in copper mineral heap leaching, June 9, 2010, Hamburg, Copper 2010.
69. Predicting Leaching Solution pH and Acid Consumption in Copper Heap Leaching, June 8, 2010, Hamburg, Copper 2010.
70. Measuring and modeling copper electrowinning current efficiency in chloride media, June 9, 2010, Hamburg, Copper 2010.
71. "Parameter Optimization to Synthesize High Quality Single Phase CZTS Film" to be presented at TMS 2011 Annual meeting.
72. "Synthesis and characterization of a new TPA-Thiophene based molecule for potential Organic PV applications" by Prashant K Sarswat , Amarchand Sathyapalan and Michael L Free APS 2011 March meeting.
73. "Understanding and Modeling the Effects of Thermal Exposure on AA5083 and Related Alloy Susceptibility to Corrosion", Materials Science and Eng. Department Graduate Seminar, April 13, 2011.
74. Gold adsorption, elution, and electrowinning, Goldfields/Univ. of Mines and Technology, Tarkwa, Ghana, July 27, 2011.
75. "Long-term Corrosion Damage Prediction Modeling of AA5083 Alloys Based on Experiment, Theory, and Molecular Dynamics Simulations," DoD Corrosion Conference, July 31-August 5, 2011, LaQuinta Resort and Club in LaQuinta, California.
76. "Evaluation of Mass Transport Effects on the Nucleation and Growth of Electrodeposits," Keynote paper, Fray International Symposium, Nov. 29, 2011.
77. "Liquid Retention Capacity Measurements and Their Relationship with Agglomeration Moisture", SME Annual Meeting, Seattle, WA, February 21, 2012.
78. "Electrometallurgy – Now and in the Future," TMS Electrometallurgy 2012 Symposium, Orlando, March 12, 2012.

79. "Copper Electrowinning Impurity Evaluation", TMS T. T. Chen Symposium, Orlando, March 12, 2012.
80. "Hydrometallurgy principles," BHP-Billiton, Escondida, Chile, October 10, 2012.
81. "Improved Modeling of Metal Extraction and Electrowinning," Invited Speaker, 1st International Metallurgical Meeting, Lima, Peru, October 27, 2012.
82. "Effects of Additives and Mass Transport on Copper Electrodeposit Roughness in Chloride Media", Murdoch University, Perth, Australia, December 12, 2012.
83. "Long-term, low temperature sensitization modeling of 5xxx alloys," NACE Annual Meeting, Orlando, March 18, 2013.
84. "Electrometallurgy Fundamentals", Tres Marias, Minas Gerais, Brazil, July 3, 2013.
85. "Production of High Quality Metals from Minerals Through Controlled and Sustainable Electrochemistry", keynote speaker, ISE Annual Meeting, Queretaro, Mexico, September 12, 2013.
86. "Evaluation of Crushed Ore Agglomeration for Copper Ores," Copper 2013, Santiago Chile, Dec. 4, 2013.
87. "Copper Extraction and Recovery from Chalcopyrite in Chloride Media," Copper 2013, Santiago, Chile, Dec. 4, 2013
88. "Long-term corrosion sensitization modeling and validation for 5xxx alloys," Materials Science and Engineering/Metallurgical Engineering Seminar, January 29, 2014.
89. "Sensitization modeling of 5xxx alloys", NACE Annual Meeting, San Antonio, March 10, 2014.
90. "Modeling and Measuring Electrodeposition Parameters Near Electrode Surfaces to Facilitate Cell Performance Optimization," Proceedings of the 7th International Symposium on Hydrometallurgy 2014, Victoria, Canada, June 24, 2014.
91. "Incorporating Mineral Associations, Comminution, Agglomeration, and Loading in Heap Leach Modeling," Proceedings of the 7th International Symposium on Hydrometallurgy 2014, Victoria, Canada, June 25, 2014.
92. "Hydrometallurgy Teaching Tools to Help Prepare Students for Employment," Proceedings of the 7th International Symposium on Hydrometallurgy 2014, Victoria, Canada, June 25, 2014.

93. Modeling hydrometallurgical extraction of metals from heterogeneous materials, Shechtman International Symposium, (plenary presentation), Cancun, Mexico, June 30, 2014.
94. Incorporating Mineral Associations, Comminution, Agglomeration, and Loading in Heap Leach Modeling, International Minerals Engineering Congress, San Luis Potosi, Mexico, Kenote Speaker, September 23, 2014.
95. Transforming Rocks into Metals: Applying Inorganic Chemistry and Modeling to Predict Industrial Performance, Chemistry Department Guest Lecture, University of Utah, October 7, 2014.
96. Developing ecofriendly energy saving chemical routes for titanium powder production from titanium ore, invited speaker, MS&T, October 14, 2014.
97. Modeling and Validating Electrodeposition for Commercial Applications, Invited talk, National Metallurgical Laboratory, Jamshedpur, India, January 19, 2015.
98. Modeling Heap Leaching PLS from Ore Characteristics and Leaching Parameters, Plenary Speaker, International Conference on the "Processing of Lean Grade and Urban Ores, Jamshedpur, India, January 20, 2015.
99. Producing smooth cathodes, invited presentation, AngloAmerican Platinum, Rustenburg, South Africa, January 26, 2015.
100. Evaluating the Effects of Flow Rate and Concentration Changes on Copper Ore Heap Leaching, Invited speaker, SME Annual Meeting, Denver, February, 16, 2015.
101. Corrosion Inhibition Modeling for Mixed Surfactant Systems, NACE Annual Meeting, Dallas, Texas, March 16, 2015.
102. Novel Methods for Titanium Powder Synthesis, TMS Annual Meeting, Orlando, Florida, March 18, 2015.
103. Modelling Heap Leaching PLS from Valuable Mineral Associations and Leaching Parameters, Heap Leach Solutions 2015, Reno, Nevada, September 15, 2015.
104. "Mixed-Surfactant Aggregation and Adsorption Effects on Steel Corrosion Inhibition in Aqueous Media with Salt" DoD Corrosion Conference, Pittsburgh, November 17, 2015.
105. "Long-Term Al 5xxx Alloy Sensitization Modeling and Experimental Validation," DoD Corrosion Conference, Pittsburgh, November 17, 2015.
106. "Characterization of Intragranular Mg-rich Precipitates Formed in Al 5xxx Alloys Aged at 343 K" TMS Annual Meeting, Nashville, TN, February 18, 2016.

107. Electrochemical Kinetics, Minerals and Metals Group, Sepon, Laos, March 9, 2016.
108. “Enhanced Removal of Nanoparticles Using Surfactants”, invited presentation, MRS Annual Meeting, Phoenix, AZ, March 30, 2016.
109. “Cathode Corrosion, Anode Lifetime, and Short-Circuiting,” Teck, Trail, British Columbia, Canada, May, 18, 2016.
110. “Modeling Electrowinning and Electrorefining”, short course, Electrometallurgy 2016, Quebec City, Canada, September 10, 2016.
111. “Modeling of Agglomerate Size Distribution for Heap Leaching,” IMPC 2016, Quebec City, Canada, September 12, 2016.
112. “Electrometallurgy Innovations,” keynote presentation, Electrometallurgy 2016, Quebec City, Canada, September 13, 2016.
113. “Modeling Electrometallurgy Topography,” Electrometallurgy 2016, Quebec City, Canada, September 12, 2016.
114. “Slime Mobility, Availability, and Transport Effects on cathode Purity in Copper Electrorefining,” Copper 2016, Kobe, Japan, November 15, 2016.
115. “Critical Characterization and Modeling of Electrowinning Systems for Optimization,” Copper 2016, Kobe, Japan, November 15, 2016.
116. “Multi-Physics Modelling and Validation of Copper Heap Leaching Performance,” Copper 2016, Kobe, Japan, November 15, 2016.
117. “Electrochemical Kinetics Principles and Applications,” Freeport-McMoran Inc., Morenci, Arizona, December 7, 2016.
118. “Conceptualization of Doped Black P Thin Films for Potential Use in Photovoltaics with Validation from First Principle Calculations,” TMS Annual Meeting, San Diego, California, March 2, 2017.
119. “Microstructural Influences of Corrosion Sensitization in Al 5XXX Series Aluminum Alloys” NACE Annual Meeting, March 29, 2017.
120. “Alloy Variability in Al5xxx Sensitization Prediction” DoD Corrosion Conference, Birmingham, AL, August 9, 2017.
121. “The Role of Scrap Recycling in the USA Circular Economy

A Case Study of Copper Scrap Recycling”, (in collaboration with Phillip Mackey and Nubia Cardona) SME Annual Meeting, Minneapolis, MN, February 27, 2018.

122. “Performance Modeling and Validation for Extraction, Recovery, and Purification of Metals,” SME Annual Meeting, Minneapolis, MN, February 28, 2018.

123. “Recycling”, The REMADE Institute, Webinar, June 19, 2018.

124. “Understanding Surfactants and Their Role in Corrosion Inhibition”, Northeastern University Satellite Campus, Quinhuangdao, China, July 24, 2018.

125. “Innovations in Metallurgical Processing”, Northeastern University, Shenyang, China, July 25, 2018.

126. “Innovations in Metallurgical Processing”, Northeastern University, Shenyang, China, July 25, 2018.

127. “Understanding the Role of Surfactants in Corrosion Inhibition”, China-Canada NonFerrous Metallurgy Forum, Shenyang, China, July 26, 2018.

128. “Metallurgical Processing”, Shanghai University, Shanghai, China, July 30, 2018.

129. “Hydrogen Assisted Magnesium Reduction of TiO_2 ”, Extraction 2018, Ottawa, Canada, August 28, 2018.

130. “Electrochemical and Frequency Assisted Separation Methods for Lithium-7 Enrichment From Liquid Media”, Critical Metals Processing 2018, Ottawa, Canada, August 28, 2018.

131. “Regulatory Mechanism of Anode Slime Behavior”, Hydrometallurgy 2018, Ottawa, Canada, August 28, 2018.

132. “Study of the Rate Controlling Steps in the Removal of Magnesium Impurities in Hydrogen Assisted Magnesiothermic Reduction of TiO_2 by Leaching”, Hydrometallurgy 2018, Ottawa, Canada, August 28, 2018.

133. “Extraction and Recovery of Rare Earth Elements from Low-Grade Material”, Hydrometallurgy 2018, Ottawa, Canada, August 28, 2018.

134. “Economic Extraction and Recovery of Rare Earth Elements from Coal Waste”, AIChE Annual Meeting, Pittsburgh, PA, November 1, 2018.

135. “Innovations in Metallurgical Engineering to Save Energy and Lower Costs,” Central South University, Changsha, China, December 11, 2018.

136. “Metal Recycling”, Remade Institute Webinar, June 25, 2019.
137. “Experimental Measurements of the Copper Electrowinning Behavior and Current Efficiency Pre and Post Shorting, Copper 2019, August 21, 2019
138. “Extraction and Recovery of Rare Earth Elements from Coal Waste”, Pittsburgh Coal Conference, September 5, 2019.
139. “Utilizing Biooxidation in a Flow Sheet to Facilitate Low-Cost Rare Earth Elements Extraction from Coal-Based Resources and Eliminate Future Acid Mine Drainage”, AIChE Annual Meeting, November 14, 2019.
140. “Low Cost Metal Recovery from E-Waste”, TMS Annual Meeting, February 24, 2020.
141. “Hydrometallurgical Removal of Mg Impurities in Hydrogen Assisted Magnesiothermic Reduction of TiO₂”, SME Annual Meeting, February 25, 2020.
142. “Utilizing Biooxidation to Facilitate Low-Cost Rare Earth Elements Extraction from Coal-Based Resources and Eliminate Future Acid Mine Drainage”, SME Annual Meeting, February 26, 2020.
143. “Extraction of Rare Earth Elements from Coal Waste”, 2020 Utah Coal Conference, , virtual meeting, November 12, 2020.
144. “Evaluating and Comparing HEAs with and without Ti” ICAM 2020, virtual meeting presentation, November 18, 2020.

Invention Disclosures and Patent Information:

D. A. Dahlstrom, M. L. Free, S. Nagpal, and T. Oolman, “Method for Improved Bioleaching,” University of Utah Invention Disclosure U-1770, 1992.

M. L. Free and D. O. Shah, “Method of Decreasing Particle Adhesion to Coated Silicon Wafer Surfaces,” submitted to University of Florida and Sematech (funding agency), 1996.

M. L. Free and D. O. Shah, “Method of Removing Amphiphilic Molecules from Surfaces,” submitted to University of Florida and Sematech (funding agency), 1996.

M. L. Free, “Electrochemical Method of Reducing Scaling on or in Metal Pipes,” University of Utah, 1997 (U-2550).

M. L. Free, “Method of Applying Metallic Coatings on Objects of All Sizes,” University of Utah, 1998 (U-2607).

M. L. Free, "Electrically-Assisted Method of Applying Metallic Coatings on Objects with Surfaces that Conduct Electricity," University of Utah, 1998 (U-2621).

M. L. Free, "Coupled Electrochemical Mineral Oxidation and Metal Recovery," University of Utah, 2000 (U-3114).

M. L. Free, "Coupled Electrochemical Sulfide Mineral Dissolution and Metal Recovery in Halide Media," University of Utah, 2001 (U-3235).

M. L. Free, "On-Line Corrosion Course," University of Utah, 2001 (U-3292)

M. L. Free, D. P. Harding, "A Virtual Electrochemical Laboratory," University of Utah, 2002 (U-3363).

M. L. Free, J. D. Miller, R. Bhide, "Electrochemical Reduction of Ferric Ions Using Hydrogen Gas," University of Utah, 2003, (U-3573).

M. L. Free, A. Wessman, "Removal of Toxic Metals from Blood" University of Utah, 2004, (U-3766).

E. Bamberg, D. R. Rakwal, D. Jorgensen, I. Harvey, M. L. Free, and A. K. Balaji, "Systems and Methods for Recycling Semiconductor Material Removal from a Raw Semiconductor Boule," (Provisional U. S. Patent filed January 25, 2007, Serial No. 60/886,645).

P. Sarswat, M. L. Free, A. Tiwari, M. Snure, Synthesis and characterization of co-electrodeposited CZTS and doped CZTS thin film, 2009. (U-4779) (Patent application filed 2010)

D. Jack Adams, Michael L. Free, John D. McLennan, Jack (John R.) Hamilton Optimization of Biogenic Methane Production from Hydrocarbon Sources. Status: Pending. Type: Provisional. Inventors:. File date 04/15/2011. Assignee: The University of Utah. Country: United States.

Michael L. Free, Amarchand Sathyapalan, Daniel H. Darlington Recovery and Recycling of Zirconium from Mixed Nitric Acid and Hydrofluoric Acid Solutions, (U-5101). 05/24/2011.

Michael L. Free, Prashant Kumar Sarswat, Amarchand Sathyapalan Synthesis of a New TPA-Thiophene Based Molecule for Organic Photovoltaic Applications, (U-5115). 06/07/2011.

Prashant K Sarswat, Michael L Free, "Synthesis of CZTS Nanopowder and use thereof in Thin Film Solar cell" (invention disclosure U-5268), 2011.

Michael L. Free, High Capacity Hybrid Flow Battery, " (invention disclosure U-5359), 2012.

Prashant K Sarswat, Michael L Free, "Rapid synthesis of CZTS Nanoparticles" (invention disclosure U-5322), 1/2012.

Joshua M. Sewell, John D. McLennan, D, Jack Adams, Jack (John R.) Hamilton, Michael L. Free, Aleksandra Opara, "Permeability Modification and Fines and Damage Removal in Propped Coalbed Fractures Using Micro-Organisms", (invention disclosure U-5388), 2012.

Prashant K. Sarswat, Michael L. Free, "Rapid Synthesis of $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) Nanoparticles (invention disclosure U-5322), 2012.

Michael L. Free, High Capacity Hybrid Flow Battery, " (invention disclosure U-5359), 2012.

Amarchand Sathyapalan, Michael L. Free, Swomitra K. Mohanty, Manoranjan Misra, "Synthesis and Application of New Materials for Portable Colorimetric Detection and Decommissioning of Improvised Explosives, " (invention disclosure U-5267), 2012.

Prashant K Sarswat, Michael L Free Synthesis of CZTS Nanopowder and Use Thereof in Thin Film Solar Cell (invention disclosure U-5268), 2012.

Michael L. Free, Amarchand Sathyapalan
Enhanced Titanium Production By a Green Chemical Synthesis Route, U-5594. 04/29/2013.

Amarchand Sathyapalan, Prashant Kumar Sarswat, Michael L. Free Non-Invasive Selective Colorimetric Ketone Body Detection From Human Breath, U-5596. 04/30/2013.

Swomitra K. Mohanty, Amarchand Sathyapalan, Monalisa Panda, Manoranjan Misra, Michael L. Free Ionic Liquid Bi-functional Heterogeneous Catalyst For Conversion of High Free Fatty Acid Containing Biomass to Biofuels, U-5600. 05/14/2013.

Prashant Kumar Sarswat, Michael L. Free Quantum Dot Based Nanosensing Platform for Selective Detection of Volatile Organic Biomarkers, U-5681. 11/01/2013.

Amarchand Sathyapalan, Michael Free, Zak Fang Low cost method for titanium production from ilmenite, U-6018, 2015.

Michael L. Free, Isotope separation technology, U-6007. 08/21/2015.

Zhigang Zak Z. Fang, Peng Fan, Scott C. Middlemas⁴⁷, Jun Guo, Ying Zhang, Michael L. Free, Amarchand Sathyapalan, Yang Xia Producing a Titanium Product, 2016. US Patent US 10,190,191 B2, 2019.

Michael L. Free, Molecule, atom, ion, isotope, and nanoparticle separator, U-6480, 2017.

Michael L. Free and Prashant K. Sarswat, THIN LIQUID FILM SEPARATORS AND METHODS OF USING THE SAME, US Patent Application, 62 806,032, Feb 15, 2019.

Research Projects: > 70 projects

Consulting: paid consultant to 40 companies