Raymond R. Unocic, Ph.D.

Senior R&D Staff Scientist
Electron and Atom Probe Microscopy Group
Center for Nanophase Materials Sciences
Oak Ridge National Laboratory
Website GoogleScholar

Education:

Ph.D. (2008) *Materials Science and Engineering*: The Ohio State University, Columbus, OH
M.S. (2003) *Materials Science and Engineering*: Lehigh University, Bethlehem, PA
B.S. (2000) *Metallurgical Engineering*: The Ohio State University, Columbus, OH

Research Expertise:

- ~ 20 Years Research Experience in Electron Microscopy
- Expertise in the development and application of advanced *in situ* characterization methods to probe the mechanisms and kinetics of materials transformations in challenging liquid and gaseous environments and under electrochemical, electrical bias, and thermal exposure.
- Expertise in the utilization of aberration-corrected STEM/EELS/EDS to probe the atomic- scaled structure, chemistry and defects of materials to elucidate nanomaterial functionality.
- Energy Storage Materials, 2D Materials, Catalysts, Structural Materials.

Research and Professional Experience:

2019- *Present*	Senior R&D Staff Scientist	Oak Ridge National Laboratory
2017- *Present*	Adjunct Professor in Materials Science	Georgia Institute of Technology
2017- *Present*	UTK Bredesen Center Joint Faculty	University of Tennessee Knoxville
2013-*2019*	R&D Staff Scientist	Oak Ridge National Laboratory
2011-2013	R&D Associate	Oak Ridge National Laboratory
2009-2011	Alvin M. Weinberg Fellowship	Oak Ridge National Laboratory (Mentor: Karren L. More)
2008-2009	Postdoctoral Researcher	The Ohio State University
2002-2008	Graduate Research Associate	The Ohio State University (Mentor: Michael J. Mills)

Honors and Awards:

2018 R&D 100 Award: The Atomic Forge
2018 Best Presentation Award at the 19th International Microscopy Congress in Sydney Australia
2015 R&D 100 Award: Porous Graphene Desalination Membrane
2015 ORNL/UT Battelle Research Team Award: Porous Graphene Desalination Membrane
2015 Significant Event Award: Graphene Desalination Membrane, ORNL
2015 Significant Event Award: Development of Scanning Electron Nano-positioning System, ORNL
2013 Significant Event Award: Na-Ion Battery Research, ORNL
2012 Microanalysis Society Birks Award for Best Paper at the Microscopy and Microanalysis Meeting
2009 Alvin M. Weinberg Early Career Fellowship, Oak Ridge National Laboratory
2009 1st Place Transmission Electron Microscopy Class, International Metallographic Contest
2004 Best in Show, Jacque-Lucas Award, International Metallographic Contest
2001 New Jersey Zinc Graduate Fellowship in Metallurgy, Lehigh University
2000 National Collegiate Inventors Competition Winner: Ceramic Matrix Composite Processing

U.S. Patents (4 Total):

2019 Borisevich AY, Kalinin SV, Jesse S, Lupini AR, Unocic RR, He Q, "Bulk Nanofabrication with Single Atomic Plane Precision via Atomic-level Sculpting of Crystalline Oxides," U.S. Patent No. 10400351.
2019 Mahurin SM, Vlassiouk I, Dai S, Surwade S, Unocic RR, Smirnov S,"Nanoporous Graphene Membrane for Desalination of Salt Water," U.S. Patent No. 10233098.
2019 Nanda J, Dudney NJ, Narula C, Pannala S, Unocic RR, Martha S, "High Energy Density Secondary Lithium Batteries," U.S. Patent No. 10224565.
2003 Sandhage KH, Unocic RR, Dickerson MB, Guerra KT, Timberlake MJ, "Method for Fabricating High- Melting, Wear-Resistant Ceramics and Ceramic Composites at Low Temperatures," U.S. Patent No. 6598656.

Invited Book Chapters:

1. Sang X, Naguib M, Alhabeb M, Unocic RR, "Effect of Synthesis Methods on the structure and defects of 2D MXenes," in 2D Metal Carbides and Nitrides (MXenes): Structures, Properties and Applications, Springer, (2020).
2. Unocic RR, More KL, "Application of Electrochemical Liquid Cells for Electrical Energy Storage and Conversion Studies," in Liquid Cell Microscopy, Cambridge University Press. Eds. Frances Ross, (2016).
3. Sandhage KH, Allan SM, Dickerson MB, Ernst EM, Gaddis CS, Shian S, Weatherspoon MR, Ahmad G, Cai Y, Haluska MS, Snyder RL, Unocic RR, Zalar FM, "Inorganic Preforms of Biological Origin: Shape-Preserving Reactive Conversion of Biosilica Microshells (Diatoms)," Handbook of Biomineralization, Eds E. Bauerlein, P. Behrens, Vol. 2 (Wiley-VCH, Weinheim, Germany) pp. 235-253, 20, (2007).

Journal Articles Published in Peer Reviewed Journals: [h index as of 10/14/2020: h-49 (google scholar)

144. Guo W, Mahurin SM, Unocic RR, Luo H, Dai S, "Broadening the Gas Separation Utility of Monolayer Nanoporous Graphene Membranes by an Ionic Liquid Gating," Nano Letters, (2020).
143. Unocic RR, Jungjohann KL, Mehdi BL, Browning ND, Wang C, "In-Situ Electrochemical Scanning Transmission Electron Microscopy of Electrode-Electrolyte Interfaces," MRS Bulletin, (2020).
142. Li X, Dyck O, Unocic RR, Ievlev A, Jesse S, Kalinin SV, "Statistical Learning of Governing Equations of Dynamics from in-situ Electron Microscopy Imaging Data," Materials & Design, (2020).
141. Boebinger MG, Yarema O, Yarema M, Unocic KA, Unocic RR, Wood V, McDowell MT ,"Spontaneous and Reversible Hollowing," Nature Nanotechnology, 15, 475-481, (2020).
140. Zhou D, Lang J, Yoo N, Unocic RR, Wu Q, Li B, "Fluid Guided CVD Growth for Large-Scale Monolayer Two-Dimensional Materials," ACS Applied Materials & Interfaces, 12, 23, 26342-26349, (2020).
139. Li X, Kahn E, Chen G, Sang X, Lei J, Passarello D, Oyedele AD, Zakhidov D, Chen K-W, Chen Y-X, Hsieh S-H, Fujisawa K, Unocic RR, Xiao K, Salleo A, Toney MF, Chen C-H, Kaxiras E, Terrones M, Yakobson BI, Harutyunyan AR, "Surfactant-Mediated Growth and Patterning of Atomically Thin Transition Metal Dichalcogenides," ACS Nano, 14, 6, (2020).
138. Mukherjee D, Gamler JTL, Skrabalak SE, Unocic RR, "Lattice Strain Measurement of Core@Shell Electrocatalysts with 4D-STEM Nanobeam Electron Diffraction," ACS Catalysis, 10, 10, 5529-5541, (2020).
137. Hu G, Fung V, Sang X, Unocic RR, Ganesh P, "Predicting Synthesizable Multi-Functional Edge Reconstructions in Two-Dimensional Transitional Metal Dichalcogenides," npj Computational Materials, 6, 44, (2020).
136. Cui W, Hu Z-H, Unocic RR, Van Tendeloo G, Sang X, "Atomic defects, functional groups and properties of MXenes," Chinese Chemical Letters, 2020.
135. Zhou X, Chen L, Sterbinsky GE, Mukherjee D, Unocic RR, Tait SL, "Pt-Ligand single-atom catalysis: tuning activity by oxide support defect density," Catalysis Science & Technology, 10, 3353-3365, (2020).
134. Hernández- Escobar D, Unocic RR, Kawasaki M, Boehlert CJ, "High-Pressure Torsion Processing of Zn-3Mg (wt.%) Alloy and its Hybrid Counterpart: A Comparative Study," Journal of Alloy and Compounds, 831, 154891, (2020).
133. Gamler JTL, Leonardi A, Sang X, Koczkur KM, Unocic RR, Engel M, Skrabalak SE, "Effect of Lattice Mismatch and Shell Thickness on Strain in Core@Shell Nanocrystals," Nanoscale Advances, 2, 1105-1114, (2020).
132. Zhu Y, Poplawsky JD, Li S, Unocic RR, Taylor CD, Locke JS, Marquis E, Frankel GS ,"Localized Corrosion at nm-Scale Hardening Precipitates in Al-Cu-Li Alloys," Acta Materialia, 189,, 204-213, (2020).
131. Misra S, Aguiar JA, Gardner S, Sang X, Unocic RR, Munshi A, Sampath WS, Ferekides CS, Scarpulla MA, "Cadmium Selective Etching in CdTE Solar Cells Produces Detrimental Narrow-gap Te in Grain Boundaries," ACS Applied Energy Materials, 3,2, 1749-1758, (2020).
130. Aguiar JA, Gong ML, Unocic RR, Tasdizen T, Miller BD, "Decoding Crystallography from High-resolution Electron Imaging and Diffraction Datasets with Deep Learning," Science Advances, 5(10), eaaw1949, (2019).
129. Sang X, Li X, Puretzky AA, Geohegan DB, Xiao K, Unocic RR, "Atomic Insight into Thermolysis-Driven Growth of Two-Dimensional MoS_2," Advanced Functional Materials, 1902149, (2019).
128. Dyck O, Ziatdinov, Lingerfelt DB, Unocic RR, Hudak BM, Lupini AR, Jesse S, Kalinin SV, "Atom-by-Atom Fabrication with electron Beams," Nature Reviews Materials, 4, 497-507, (2019).
127. Ashberry HM, Gamler JTL, Unocic RR, Skrabalak SE, "Disorder-to-Order Transition Mediated by Size Focusing: a Route towards Monodisperse Intermetallic Nanoparticles," Nano Letters, 19(9), 6418-6423, (2019).
126. Hu G, Fung V, Sang X, Unocic RR, Ganesh P, "Superior Electrocatalytic Hydrogen Evolution at Engineered Non-Stoichiometric Two-Dimensional Transition Metal Dichalcogenide Edges," Journal of Materials Chemistry A, 7(31), 18357-18364, (2019).
125. Hernández-Escobar D, Marcus J, Han J-K, Unocic RR, Kawasaki M, Boehlert CJ, "Synergistic Effect of Post-Deformation Annealing on the Micro-Mechanical Behavior of Zn-Mg Hybrids Processed by High-Pressure Torsion," Materials Science and Engineering A, 13, 771, 138578, (2020).
124. Brahlek M, Rimal G, Ok JM, Mukherjee D, Mazza AR, Lu Q, Lee HN, Ward TZ, Unocic RR, Eres G, Oh S, "Growth of Metallic Delafossite PdCoO2 by Molecular Beam Epitaxy," Physical Review Materials, 3(9), 093401, (2019).

123. Key J, Zhu S, Rouleau C, Unocic RR, Xie Y, Kacher JP, "Investigating Local Oxidation Processes in Fe Thin Films in a Water Vapor Environment by in situ Liquid Cell TEM," Ultramicroscopy, 209, 112842, (2020).
122. Gamler JTL, Ashberry HA, Sang X, Unocic RR, Skrabalak SE, "Building Random Alloy Surfaces from Intermetallic Seeds: a General Route to Strain-Engineered Electrocatalysts with High Durability," ACS Applied Nano Materials, 2(7), 4538-4546, (2019).
121. Chen H, Lin W, Zhang Z, Jie K, Mullins DR, Sang X, Yang S, Jafta CJ, Bridges CA, Hu X, Unocic RR, Fu J, Zhang P, Dai S, "Mechanochemical Synthesis of High Entropy Oxide Materials under Ambient Conditions: Dispersion of Catalysts via Entropy Maximization," ACS Materials Letters, 1(1), 83-88, (2019).
120. Oyedele A, Yang S, Feng T, Haglund A, Gu Y, Puretzky A, Briggs D, Rouleau C, Chisholm M, Unocic RR, Mandrus D, Meyer HM, Pantelides S, Geohegan D, Xiao K, "Defect-mediated Phase Transformation in Anisotropic 2D PdSe2 Crystals for Seamless Electrical Contacts," Journal of the American Chemical Society, 141(22), 8928-8936, (2019)
119. Gutiérrez-Kolar J, Baggetto L, Sang X, Shin D, Yurkiv V, Mashayek F, Veith GM, Shahbazian-Yassar R, Unocic RR, "Interpreting Electrochemical and Chemical Sodiation Mechanisms and Kinetics in Tin Antimony Battery Anodes using *in situ* TEM and Computational Methods," ACS Applied Energy Materials, 2(5), 3578-3586, (2019).
118. Zeng M, Chen Y, Zhang E, Li J, Mendes RG, Sang X, Luo S, Ming W, Fu Y, Du M-H, Zhang L, Parker DS, Unocic RR, Xiao K, Wang C, Zhang T, Xiao Y, Rümmeli MH, Xiu F, Fu L, "Molecular Scaffold Growth of Two-Dimensional, Strong Interlayer-Bonding-Layered Materials," CCS Chemistry, 1, 117-127, (2019).
117. Nandi P, Sang XH, Hoglund ER, Unocic RR, Molodov DA, Howe JM, "Nano-scale mapping of the electron density of Al grain boundaries and correlation with grain-boundary energy," Physical Review Materials, 3, 053805, (2019).
116. Gamler J, Leonardi A, Ashberry H, Daanen N, Losovyj Y, Unocic RR, Engel M, Skrabalak SM, "Achieving Highly Durable Random Alloy Nanocatalysts through Intermetallic Cores," ACS Nano, 13(4), 4008-4017, (2019).
115. Stricker EA, Ke X, Wainright JS, Unocic RR, Savinell RF,"Current Density Distribution in Electrochemical Cells with Small Heights and Coplanar Thin Electrodes as used in ec-STEM Cell Geometries," Journal of the Electrochemical Society, 166(4), H126-H134, (2019).
114. Phillip ND, Ruther RE, Sang X, Wang Y, Unocic RR, Westover A, Daniel C, Veith GM, "Synthesis of Ni-rich Thin Film Cathode as Model System for Lithium Ion Batteries," ACS Applied Energy Materials, 2(2), 1405-1412, (2019).
113. Lu X, Zhang J, Puretzky AA, Yoshimura Y, Sang X, Cui Q, Li Y, Liang L, Ghosh AW, Zhao H, Unocic RR, Meunier V, Rouleau CM, Sumpter BG, Geohegan DB, Xiao K, "Isotope Engineering the Thermal Conductivity of Two-Dimensional MoS_2," ACS Nano, 13(2), 2481-2489, (2019).
112. Santodonato LJ, Liaw PK, Unocic RR, Bei H, Morris JW, "Predictive Multiphase Evolution in Al-containing High-Entropy Alloys," Nature Communications, 4520, (2018).
111. Kammert J, Xie J, Godfrey I, Unocic RR, Stavitski E, Attenkover, Sankar G, Davis R, "Reduction of Propionic Acid over Pd-Promoted ReOx/SiO2 probed by X-ray Absorption Spectroscopy and Transient Kinetic Analysis," ACS Sustainable Chemistry & Engineering, 6(9), 12353-12366, (2018).
110. Ding J, Balachandran J, Sang X, Guo W, Anchell J, Veith GM, Bridges CA, Cheng YQ, Rouleau CM, Poplawsky JD, Bassiri-Gharb, Unocic RR, Ganesh P, "Influence of Local Distortions on Proton Mobility in Acceptor Doped Perovskites," Chemistry of Materials, 30(15), 4919-4925, (2018).
109. Sang X, Li X, Zhao W, Dong J, Rouleau CM, Geohegan DB, Ding F, Xiao K, Unocic RR, "*In situ* Edge Engineering in Two-dimensional Transition Metal Dichalcogenides," Nature Communications, 2051, (2018).
108. Sang X, Xie Y, Yilmaz DE, Lotfi R, Alhabeb M, Ostadhossein A, Anasori B, Sun W, Li X, Xiao K, Kent PRC, van Duin ACT, Gogotsi Y, Unocic RR, "*In situ* atomistic insight into the growth mechanisms of single layer 2D transition metal carbides," Nature Communications, 2266, (2018).
107. Vlassiouk IV, Stehle Y, Pudasaini P, Unocic RR, Rack PD, Baddorf AP, Ivanov IN, Lavrik NV, List F, Gupta N, Bets K, Yakobson BI, Smirnov S, "Evolutionary Selection Growth of Two Dimensional Materials on Polycrystalline Substrates: The Case of Graphene," Nature Materials, 17, 318-322, (2018).
Note: DOE Office of Science Highlight: https://science.energy.gov/bes/highlights/2018/bes-2018-08-f/
106. Boebinger MG, Yeh D, Xu M, Miles BC, Papakyiakou M, Lewis JA, Kondekar NP, Cortes FJQ, Hwang S, Sang X, Su D, Unocic RR, Xia S, Zhu T, McDowell MT, "Reaction with Larger Alkali Ions Prevents Fracture in a Conversion Battery Material: Probing Nanoscale Transformations *in situ*," Joule, (2018).
105. Idrobo JC, Lupini AR, Feng T, Unocic RR, Walden FS, Gardiner DS, Lovejoy TC, Delby N, Pantelides ST, Krivanek OL, "Temperature Measurement by a Nanoscale Electron Probe using Energy Grain and Loss Spectroscopy," Physical Review Letters, 120, 095-901, (2018).
Note: DOE Office of Science Highlight: https://science.energy.gov/bes/highlights/2018/bes-2018-04-j/
104. Jin T, Sang X, Unocic RR, Kinch RT, Liu X, Hu X, Liu H, Dai S, "Mechanochemical-Assisted Synthesis of High-Entropy Metal Nitride via a Soft Urea Strategy," Advanced Materials, 10, 1707512, (2018).
103. Han J, Kammert J, Kaylor N, Zheng J, Choi E, Pham H, Sang X, Stavitski E, Attenkofer K, Unocic RR, Datye A, Davis R, "Atomically-Dispersed Co and Cu and N-doped Carbon for Reactions involving C-H Activation," ACS Catalysis, 8(5), 3875-3884, (2018).

102. Ding J, Balachandran J, Sang X, Guo W, Veith GM, Bridges CA, Rouleau CM, Poplawsky JD, Bassiri-Gharb N, Ganesh P, Unocic RR, "Influence of Non-stoichiometry on Proton Conductivity in Thin Film Yttrium-doped Barium Zirconate," ACS Applied Materials & Interfaces, 10(5), 4816-4823, (2018).
101. Kim S, Ievlev AV, Jakowski J, Vlassiouk IV, Sang X, Brown C, Dyck O, Unocic RR, Kalinin SV, Belianinov A, Sumpter BG, Jesse S, Ovchinnikova OS, "Multi-Purposed Ar Gas Cluster Ion Beam Processing for Graphene Engineering," Carbon, 131, 142-148, (2018).
100. Canepa S, Sneed BT, Sun H, Unocic RR, Molhave K, "*In situ* Liquid Cell STEM Study on the Influence of CTAB on Au Nanocrystal Formation," Journal of Physical Chemistry A. 122(4), 2350-2357, (2018).
99. Ziatdinov M, Dyck O, Maksov A, Li X, Sang X, Xiao K, Unocic RR, Vasudevan RK, Jesse S, Kalinin SV, "Deep Learning of atomically resolved scanning transmission electron microscopy images: chemical identification and tracking local transformations," ACS Nano, 11(12), 12742-12752, (2017).
98. Xu D, Chen W, Zeng M, Xue H, Chen Y, Sang X, Xiao Y, Zhang T, Unocic RR, Xiao K, Fu L, "Crystal Field Tuning of Photoluminescence in Lanthanide Ions-Embedded Two-dimensional Materials," Angewandte Chemie, 130, 763-767, (2017).
97. Stehle Y, Sang X, Unocic RR, Voylov D, Jackson R, Smirnov SN, Vlassiouk IV, "Anisotropic Etching of Hexagonal Boron Nitride and Graphene: Question of Edge Terminations," Nano Letters, 17(12), 7306-7314, (2017).
96. Muckley ES, Naguib M, Wang H-W, Vlcek L, Osti NC, Sacci RL, Sang X, Unocic RR, Xie Y, Tyagi M, Mamontov E, Page KL, Kent PRC, Nanda J, Ivanov IN, "Multimodality of Structural, Electrical, and Gravimetric Responses of Intercalated MXenes to Water," ACS Nano, 11(11), 11118-11126, (2017).
95. Thompson MW, Dyatkin B, Wang H-W, Turner CH, Sang X, Unocic RR, Iacovella CR, Gogotsi Y, van Duin ACT, Cummings PT, "An Atomistic Carbide-Derived Carbon Model Generated via ReaxFF," C, 3, 32, 2017.
94. Yurkiv V, Gutierrez-Kolar JS, Unocic RR, Ramsubramanian A, Shahbazian-Yassar R, Mashayek F, "Competitive Ion Diffusion within Grain Boundary and Grain Interiors in Polycrystalline Electrodes with the Inclusion of Stress Field," accepted for publication in *Journal of the Electrochemical Society* (2017).
93. Ievlev AV, Jakowski J, Burch MJ, Iberi V, Hysmith H, Joy DC, Sumpter BG, Belianinov A, Unocic RR, Ovchinnikova OS, "Building with ions: Towards Direct-Write of Platinum Nanostructures using In Situ Liquid Cell Helium Ion Microscopy," Nanoscale, 9, 12949-12956, (2017).
Note: DOE Office of Science Highlight https://science.energy.gov/bes/highlights/2018/bes-2018-05-b/
92. Jarvis K, Wang C-C, Varela M, Unocic RR, Manthiram A, Ferreira PJ, "Surface Reconstruction in Li-rich Layered Oxides for Advanced Li-ion Battery Materials," Chemistry of Materials, 29(18), 7668-7674, 2017.
91. Wang C, Sang X, Gamler JTL, Chen DP, Unocic RR, Skrabalak SE, Facet-Dependent Deposition of Highly Strained Alloyed Shells on Intermetallic Nanoparticles for Enhanced Electrolysis, Nano Letters, 17(9), 5526-5532, (2017).
90. Han CW, Choksi T, Milligan C, Majumdar P, Manto MJ, Cui Y, Sang X, Unocic RR, Zemlyanov D, Wang C, Ribeiro FH, Greeley J, Ortalan V, "A Discovery of Strong Metal-Support Bonding in Nano-engineered Au-Fe_3O_4 Dumbbell-like Nanoparticles by In-situ Transmission Electron Microscopy, Nano Letters, 17(8), 4576-4582, (2017).
89. Zhao Y, Liu D, Chen J, Zhu L, Belianinov A, Ovchinnikova OS, Unocic RR, Burch MJ, Kim SJ, Hao H, Pickard DS, Li B, Thong JTL, "Engineering the thermal conductivity along and individual silicon nanowire by selective helium ion irradiation," Nature Communications, 15919, (2017).
88. Yang B, Brown CC, Huang J, Collins L, Sang X, Unocic RR, Jesse S, Kalinin SV, Belianinov A, Jakowski J, Geohegan DB, Sumpter BG, Xiao K, Ovchinnikova OS, "Enhancing Ion Migration in Grain Boundaries of Hybrid Organic-Inorganic Perovskites by Chlorine," Advanced Functional Materials, 27, 1700749, 2017.
87. Lewis BB, Winkler R, Sang X, Pudasaini PR, Stanford MG, Plank H, Unocic RR, Fowlkes JD, Rack PD, "3D Nanoprinting Via Laser-Assisted Electron Beam Induced Deposition: Growth Kinetics, Enhanced Purity and Electrical Resistivity," Beilstein Journal of Nanotechnology, 8, 801-812, (2017).
86. Sang X, Lupini AR, Ding J, Kalinin SV, Jesse S, Unocic RR, "Precision controlled atomic resolution scanning transmission electron microscopy using spiral scan pathways," Scientific Reports, 7:43585, (2017).
85. Boebinger MG, Xu M, Unocic RR, McDowell MT, "Distinct Nanoscale Reaction Pathways in a Sulfide Material for Sodium and Lithium Batteries," Journal of Materials Chemistry A, 5, 11701-11709, (2017).
84. Xie J, Yin K, Serov A, Artyushova K, Pham HN, Sang S, Unocic RR, Atannassov P, Datye AK, Davis RJ, "Selective Aerobic Oxidation of Alcohols over Atomically-dispersed Non-Precious Metal Catalysts," ChemSusChem, 10, 359-362, (2017).
83. Baturina O, Lu Qin, Xu Feng, Purdy A, Dyatkin B, Sang X, Unocic RR, Brintlinger TH, Gogotsi Y, "Effect of Nanostructured Supports on Copper Electrocatalytic Activity toward Electroreduction to Hydrocarbon Fuels," Catalysis Today, 288, 2-10, (2017).
82. Li Y, Wan S, Veith GM, Unocic RR, Paranthaman MP, Dai S, Sun X-G, "A Novel Electrolyte Additive for High Voltage $LiNi_{1.5}Mn_{0.5}O_4$ based Lithium Ion Batteries, Advanced Energy Materials, 7, 1601397, (2017).
81. Li X, Puretzky AA, Sang X, Santosh KC, Tian M, Ceballos F, Mahjouri-Samani M, Wang K, Unocic RR, Zhao H, Duscher G, Cooper VR, Rouleau CM, Geohegan DB, Xiao K, "Suppression of Defects and Deep Levels Using Isoelectronic Tungsten Substitution in Monolayer $MoSe_2$,"Advanced Functional Materials, 27, 1603850, (2017).

80. Sang X, Xie Y, Lin MW, Alhabeb M, Van Aken K, Gogotsi Y, Kent P, Xiao K, Unocic RR, "Atomic Defects in Monolayer Titanium Carbide (Ti_3C_2Tx) MXene," ACS Nano, 10(10), 9193-9200.
79. Yoon K, Rahnamoun A, Swett JL, Iberi V, Cullen DA, Vlassiouk IV, Belianinov A, Sang X, Ovchinnikova OS, Rondinone AJ, Unocic RR, van Duin ACT, Atomistic-scale simulations of defect formation in graphene under noble gas ion irradiation," ACS Nano, 10(9), 8376-8384, (2016).
78. Unocic KA, Shin D, Unocic RR, Allard LF, "NiAl Oxidation Reaction Processes Studied In Situ Using MEMS-Based Closed-Cell Gas Reaction Transmission Electron Microscopy," Oxidation of Metals, 88, 3(4), 495-508, (2017).
77. Unocic RR, Lupini AR, Borisevich AY, Cullen DA, Kalinin SV, Jesse S, "Direct-write Liquid Phase Transformations with a Scanning Transmission Electron Microscope," Nanoscale, 8(34), 15581-15588, (2016).
76. Black JM, Zhu M, Zhang P, Unocic RR, Okatan MB, Dai S, Cummings PT, Kalinin SV, Feng G, Balke N, "Fundamental aspects of electric double layer force-distance measurements at liquid-solid interfaces using atomic force microscopy," Scientific Reports, 6, 32389, (2016).
75. Rubio MA, Gunduz IE, Groven LJ, Sippel TR, Han CW, Unocic RR, Ortalan V, Son SF, "Microexplosions and Ignition Dynamics in Engineered Aluminum/Polymer Fuel Particles," Combustion and Flame, (2016). Accepted
74. Wang C, Chen DP, Sang X, Unocic RR, Skrabalak, "Size Dependent Disorder-Order Transformations in the Synthesis of Monodisperse Intermetallic PdCu Nanocatalyst," ACS Nano, 10(6), 6345-6353, (2016).
73. Xia J, Huang B, Yin K, Pham HN, Unocic RR, Datye AK, Davis RJ, "Influence of Dioxygen on the Promotional Effect of Bi during Pt-catalyzed Oxidation of 1,6-Hexanediol," ACS Catalysis, 6, 4206-4217, (2016).
72. Formo EV, Potter CB, Yang M, Unocic RR, Leonard DN, Pawel M, "How a Nanostructure's Shape Affects its Lifetime in the Environment: Comparing a Silver Nanocube to a Nanoparticle when Dispersed in Aqueous Media," Environmental Science and Technology, 50(13), 7082-7089, (2016).
71. Jesse S, Borisevich AY, Fowlkes, JD, Lupini AR, Rack PD, Unocic RR, Sumpter BG, Kalinin SV, Belianinov A, Ovchinnikova, OS, "Directing Matter: Towards Atomic Scale 3D Nanofabrication," ACS Nano, 10(6), 5600-5618, (2016).
70. Sang X, Lupini AR, Unocic RR, Chi M, Borisevich AY, Kalinin SV, Endeve E, Archibald RK, Jesse S, "Dynamic Scan Control in STEM: Spiral Scans," Advanced Structural and Chemical Imaging, 2(6), 1-8, (2016).
69. Weiner RG, Chen DP, Unocic RR, Skrabalak SE, "Impact of Membrane-Induced Particle Immobilization on Seeded Growth Monitored by In Situ Liquid Scanning Transmission Electron Microscopy," Small, 12(20), 2701-2706, (2016).
68. Smith TM, Unocic RR, Deutchmann H, Mills MJ, "Creep Deformation Mechanism Mapping in Nickel Based Superalloys," Materials at High Temperatures, 33(4-5), 372-383, (2016).
67. Economy DR, Mara NA, Schoeppner RL, Schultz BM, Unocic RR, Kennedy MS, "Identifying Deformation and Strain Hardening Behaviors of Nanoscale Metallic Multilayers through Nano-wear Testing," Metallurgical and Materials Transactions A, 47(A), 1083-1095, (2016).
66. Kercher AK, Kolopus JA, Carroll KJ, Unocic RR, Kirklin S, Wolverton C, Stooksbury SL, Boatner LA, Dudney NJ, "Mixed Polyanion Glass Cathodes: Glass-State Conversion Reactions," Journal of the Electrochemistry Society, (2016).
65. St John S, Atkinson RW, Roy A, Unocic RR, Papandrew AB, Zawodzinski TA, "The Effect of Carbonate and pH on Hydrogen Oxidation and Oxygen Reduction on Pt-Based Electrocatalysts in Alkaline Media," Journal of the Electrochemical Society, 163(3), F291-F295, (2016).
64. Ievlev AV, Jesse S, Cochell TJ, Unocic RR, Protopopescu V, Kalinin SV, "A Quantitative Description of Crystal Nucleation and Growth from In situ Liquid Scanning Transmission Electron Microscopy," ACS Nano, 9(12), 11784-11791, (2015).
63. Unocic RR, Baggetto L, Veith GM, Aguiar JA, Unocic KA, Sacci RL, Dudney NJ, More KL, "Probing Battery Chemistry with Liquid Cell Electron Energy Loss Spectroscopy," Chemical Communications, 51, 16377-16380, (2015).
62. Stehle YY, Meyer HM, Unocic RR, Kidder M, Polyzos G, Datkos P, Jackson RK, Smirnov S, Vlassiouk IV, "Synthesis of Hexagonal Boron Nitride Monolayer: Control of Nucleation and Crystal Morphology," Chemistry of Materials, 27, 8041-8047, (2015).
61. St John S, Atkinson RW, Unocic KA, Unocic RR, Zawodzinski TA, Papandrew AP, "Platinum and Palladium Overlayers Dramatically Enhance the Activity of Ruthenium Nanotubes for Alkaline Hydrogen Oxidation," ACS Catalysis, 5(11), 7015-7023, (2015).
60. Jesse S, He Q, Lupini AR, Leonard DN, Oxley MP, Ovchinnikov O, Unocic RR, Tselev A, Fuentes-Cabrera M, Sumpter BG, Pennycook SJ, Kalinin SV, Borisevich AY, "Atomic-level sculpting of crystalline oxides: towards bulk nanofabrication with single atomic plane precision," Small, 11(44), 5895-5900, (2015).
Note: DOE Office of Science Highlight https://science.energy.gov/bes/highlights/2016/bes-2016-06-d/
59. Binder AJ, Toops TJ, Unocic RR, Parks JE, Dai S, "Low Temperature CO Oxidation over a Ternary Oxide Catalyst with High Resistance to Hydrocarbon Inhibition," Angewandte Chemie, 127(45), 13461-13465, (2015).
58. Atkinson RW. St. John S, Dyck O, Unocic KA, Unocic RR, Burke CS, Cisco JW, Rice CA, Zawodzinski TA, Papandrew AB, "Supportless, Bismuth-Modified Palladium Nanotubes with Improved Activity and Stability for Formic Acid Oxidation," ACS Catalysis, 5, 5154-5163, (2015).
57. Surwade, SP, Smirnov SN, Vlassiouk IV, Unocic RR, Veith GM, Dai S, Mahurin SM, "Water desalination using nanoporous single layer graphene," Nature Nanotechnology, 10, 459-464, (2015).

56. Achtyl JL, Unocic RR, Xu L, Cai Y, Raju M, Zhang W, Sacci RL, Vlassiouk IV, Fulvio PF, Ganesh P, Wesolowski DJ, Dai S, van Duin ACT, Neurock M, Geiger FM, "Aqueous Proton Transfer across single layer graphene," Nature Communications, 6, 6539, (2015).
Note: DOE Office of Science Highlight https://science.energy.gov/bes/highlights/2015/bes-2015-07-c/
55. St. John, S, Atkinson RW, Unocic RR, Zawodzinski TA, Papandrew AB, "Ruthenium-Alloy Electrocatalysts with Tunable Hydrogen Oxidation Kinetics in Alkaline Electrolyte," Journal of Physical Chemistry C, 119(24), 13481-13487, (2015).
54. Atkinson, RW, Unocic RR, Unocic KA, Veith GM, Zawodzinski TA, Papandrew AB, "Vapor synthesis and Thermal Modification of Supportless Platinum-Ruthenium Nanotubes and Applications as Methanol Electrooxidation Catalysts," ACS Applied Materials & Interfaces, 7(19), 10115-10124, (2015).
53. Sacci RL, Black JM, Balke N, Dudney NJ, More KL, Unocic RR, "Nanoscale Imaging of Fundamental Li Battery Chemistry: Solid-electrolyte Interphase Formation and Preferential Growth of Lithium Metal Nanoclusters," Nano Letters, 15(3), 2011-2018, (2015).
52. Naguib M, Unocic RR, Armstrong BL, Nanda J," Large-scale delamination of multi-layers transition metal carbides and carbonitrides "MXenes," Dalton Transactions, 44, 9353-9358, (2015).
51. Papandrew AB, Atkinson RW, Unocic RR, Zawodzinski TA, "Ruthenium as a CO-tolerant hydrogen oxidation catalyst for solid acid fuel cells," Journal of Materials Chemistry A, 3, 3984-3987, (2015).
50. Hayes RW, Unocic RR, Nasrollahzadeh M, "Creep Deformation of AllVac 718Plus," Metallurgical and Materials Transactions A, 46A(1), 218-228, (2015).
49. Unocic RR, Sun X-G, Sacci RL, Adamczyk LA, Alsem DH, Dai S, Dudney NJ, More KL, "Direct Visualization of Solid Electrolyte Interphase Formation in Lithium-Ion Batteries with In situ Electrochemical Transmission Electron Microscopy," Microscopy and Microanalysis, 20, 1029-1037, (2014).
48. Schultz BM, Unocic RR, DesJardins JD, Kennedy MS, "Formation of a Metallic Amorphous Layer During the Sliding Wear of Ti/TiN Nanolaminates," Tribology Letters, 55, 219-226, (2014).
47. Zhou H Martha SK, Unocic RR, Meyer HM, Nanda J, Sahoo Y, Miskiewicz P, Albrecht TF, "Role of Surface Functionality on the Electrochemical Performance of Silicon Nanowire Anodes for Rechargeable Lithium Batteries," ACS Applied Materials & Interfaces, 6(10), (2014), 7607-7614.
46. Xiao, X, Liu, Z, Baggetto, L, Veith, GM, More, KL, Unocic RR, "Unraveling Manganese Dissolution/Deposition Mechanisms on the Negative Electrode in Lithium Ion Batteries." Physical Chemistry Chemical Physics, 16, (2014), 10398-10402.
45. Baggetto L, Carroll KJ, Hah H-Y, Johnson CE, Mullins DR, Unocic RR, Johnson JA, Meng YS, Veith GM, "Probing the Mechanisms of Sodium Ion Insertion into Copper Antimony Cu_2Sb Anodes," Journal of Physical Chemistry C, 118(15), (2014), 7856-7864.
44. Mehdi BL, Gu M, Parent LR, Xu W, Nasybulin EN, Chen X, Unocic RR, Xu P, Welch DA, Abellan P, Zhang JG, Liu J, Wang CM, Arslan I, Evans J, Browning ND, "*In Situ* Electrochemical Transmission Electron Microscopy for Battery Research," Microscopy and Microanalysis, 20, (2014), 484-492.
43. Sun XG, Liao C, Baggetto L, Guo B, Unocic RR, Veith GM, Dai S, "Bis(fluoromalonato)borate (BFMB) Anion Based Ionic Liquid As an Additive for Lithium-ion Batteries," Journal of Materials Chemistry A, 2, (2014), 7606-7614.
42. Baggetto L, Carroll KJ, Unocic RR, Bridges CA, Meng YS, Veith GM, "Sodium Manganese Oxide Thin Films as Cathodes for Na-Ion Batteries," Electrochemical Society Transactions, 58(12), 47-57, (2014).
41. Veith, GM, Baggetto, L, Sacci RL, Unocic RR, Tenhaeff WE, Browning JF, "Direct Measurement of the Chemical Reactivity of Silicon Electrodes with $LIPF_6$-based Battery Electrolytes," ChemComm, 50(23), (2014), 3081-3084.
40. Unocic RR, Sacci RL, Brown GM, Veith GM, Dudney, More KL, Walden FS, Gardiner DS, Damiano D, Nackashi DP, "Quantitative Electrochemical Measurements using *In Situ* ec-S/TEM Devices," Microscopy and Microanalysis, 20, (2014), 452-461.
39. Sacci RL, Dudney NJ, More KL, Parent LR, Arslan I, Browning ND, Unocic RR, "Direct Visualization of Initial SEI Morphology and Growth Kinetics During Lithium Deposition by in situ Electrochemical Transmission Electron Microscopy," Chemical Communications, 50, (2014). 2104-2107.
38. Bi Z, Paranthaman MP, Guo B, Unocic RR, Meyer HM III, Bridges CA, Sun XG, Dai S, "High Performance Cr, N Co-doped TiO_2 Mesoporous Microspheres for Li-ion Rechargeable Batteries with Enhanced Electrochemical Performance," Journal of Materials Chemistry A, 2(6), (2014), 1818-1824.
37. Arruda TM, Lawton JS, Kumar A, Unocic RR, Kravchenko II, Zawodzinski TA, Jesse S, Kalinin SV, Balke N, "In situ Formation of Micron-scale Li-metal Anodes with High Cyclability," ECS Electrochemistry Letters, 3(1), (2014), A4-A7.
36. Borisevich AY, Chi M, Unocic RR, "Functional Electron Microscopy for Electrochemistry Research: From the Atomic to Micro Scale," The Electrochemical Society-Interface, 61-67, (2014).
35. Gu M, Parent LR, Mehdi L, Unocic RR, McDowell MT, Sacci RL, Xu W, Connel JG, Xu P, Abellan P, Chen X, Zhang Y, Perea DE, Lauhon LJ, Arslan I, Zhang JG, Liu J, Cui Y, Browning ND, Wang CM, " Demonstration of an Electrochemical Liquid Cell for Operando Transmission Electron Microscopy Observation of the Lithiation/Delithiation Behavior of Si Nanowire Battery Anodes," Nano Letters, 13(12), (2013), 6106-6112.

34. Baggetto L, Allcorn E, Unocic RR, Manthiram A, Veith GM, "Extremely fast reaction kinetics of amorphous Mo_3Sb_7 thin films as anodes for Li- and Na-ion batteries," Journal of Materials Chemistry A, 1(37), (2013), 11163 - 11169.
33. Bridges CA, Harrison K, Unocic RR, Idrobo JC, Paranthaman MP, Manthiram A, "Defects in Microwave Solvothermally Grown Phospho-Olivine Nanoparticles," Journal of Solid State Chemistry, 205, (2013), 197-204.
32. Browning KL, Baggetto L, Delnick FM, Unocic RR, Dudney NJ, Veith GM, "Gas evolution from $LiCoO_2$ cathode materials: A pathway to electrolyte decomposition concomitant to SEI formation." Journal of Power Sources, 239, (2013), 341-346.
31. Yoon S, Bridges CA, Unocic RR, Paranthaman MP, "Mesoporous TiO_2 Spheres with a Nitridated Conducting Layer for Lithium-ion Batteries," Journal of Materials Science, 48, (2013), 5125-5131.
30. Martha SK, Nanda J, Kim Y, Unocic RR, Pannala S, Dudney NJ, "Solid Electrolyte Coated High Voltage Layered-Layered Lithium-rich Composite Cathode: $Li_{1.2}Mn_{0.5}25Ni_{0.175}Co_{0.1}O_2$," *Journal of Materials Chemistry A*, 1, (2013), 5587-5595.
29. Baggetto L, Meisner RP, Ganesh P, Unocic RR, Bridges CA, Jumas J-C, Veith GM, "Characterization of Sodium Ion Electrochemical Reactions with Tin Anodes," Journal of Power Sources, 234, (2013), 48-59.
28. Phillips PJ, Unocic RR, Mills MJ, "Low cycle fatigue of a polycrystalline Ni-based superalloy: Deformation substructure analysis," International Journal of Fatigue, 57, (2013), 50-57.
27. Li HQ, Martha SK, Unocic RR, Luo HM, Dai S, Qu J, "High cyclability of ionic liquid-produced TiO_2 nanotube arrays as an anode material for lithium-ion batteries," Journal of Power Sources, 218, (2012), 88-92.
26. Baggetto L, Unocic RR, Dudney NJ, Veith GM, "Fabrication and characterization of Li-Mn-Ni-O sputtered thin film high voltage cathodes for Li-ion batteries," Journal of Power Sources, 211, (2012), 108-118.
25. Qiao, Z-A, Brown SS, Adcock J, Veith GM, Bauer JC, Payzant A, Unocic RR, Dai S, "A Topotactic Synthetic Methodology for Highly Fluorine-Doped Mesoporous Metal Oxides," Angewandte Chemie, 51(12), 2888-2893, (2012).
24. Chan-Thaw CE, Villa A, Veith GM, Kailasam K, Adamczyk LA, Unocic RR, Prati L, Thomas A, "Influence of Periodic Nitrogen Functionality on the Selective Oxidation of Alcohols," Chemistry-An Asian Journal, 7(2), 387-393, (2012).
23. Yoon, S., Liao, C., Sun, X-G., Bridges CA, Unocic RR, Nanda J, Dai S, Paranthaman MP, "Conductive surface modification of $LiFePO_4$ with nitrogen-doped carbon layers for lithium-ion batteries," Journal of Materials Chemistry, 22, 4611-4614 (2012).
22. Unocic RR, Zhou N, Kovarik L, Shen C, Wang Y, Mills MJ, "Dislocation Decorrelation and Relationship to Deformation Microtwins During Creep of a γ′ Precipitate Strengthened Ni-Base Superalloy," *Acta Materialia*, 59, (2011), 7325-7339.
21. Kim Y, Veith GM, Nanda J, Unocic RR, Chi M, Dudney NJ, "High Voltage Stability of $LiCoO_2$, Particles with a Nano-scale Lipon Coating," *Electrochimica Acta*, 56, (2011), 6573–6580.
20. Liu H, Bi Z, Sun X, Unocic RR, Paranthaman MP, Dai S, Brown GM, "Mesoporous TiO_2–B Microspheres with Superior Rate Performance for Lithium Ion Batteries," *Advanced Materials*, 23, (2011), 3450-3454.
18. Liu R, Mahurin SM, Li C, Unocic RR, Idrobo JC, Gao H, Pennycook SJ, Dai S, "Dopamine as a Carbon Source: The Controlled Synthesis of Hollow Carbon Spheres and Yolk-Structured Carbon Nanocomposites," *Angewandte Chemie*, 50, (2011), 6799 –6802.
17. Grassman TJ, Brenner MR, Gonzalez M, Carlin AM, Unocic RR, Dehoff RR, Mills MJ, Ringel SA, "Characterization of Metamorphic GaAsP/Si Materials and Devices for Photovoltaic Applications," *IEEE Transactions of Electron Devices*, 57, 10, (2010), 3361-3369.
16. Wang XQ, Fulvio PF, Baker GA, Veith GM, Unocic RR, Mahurin SM, Chi M, Dai S, "Direct Exfoliation of Natural Graphite into Micrometre Size Few Layers Graphene Sheets using Ionic Liquids," *Chemical Communications*, 46, 25, (2010), 4487-4489.
15. Phillips PJ, Unocic RR, Kovarik L, Mourer D, Wei D, Mills MJ, "Low Cycle Fatigue of a Ni-based Superalloy: Non-Planar Deformation," *Scripta Materialia,* 62, 10, (2010), 790-793.
14. Unocic RR, Unocic KA, Hayes RW, Daehn GS, Mills MJ, "A TEM Study of Creep Deformation Mechanisms in Allvac 718Plus," Superalloy 718 and Derivatives (2010), 607-615.
13. Unocic, KA, Unocic, RR, Pint, BA and Hayes, RW, "Effect of Microstucture and Environment on the High-Temperature Oxidation Behavior of Alloy 718Plus," Superalloy 718 and Derivatives (2010), 977-991.
12. Grassman TJ, Brenner MR, Rajagopalan S, Unocic RR, Dehoff RR, Mills MJ, Fraser HL, Ringel SA, "Control and Elimination of Nucleation-Related Defects in GaP/Si(001) Heteroepitaxy," *Applied Physics Letters*, 94, (2009), 232106.
11. Kovarik L, Unocic RR, Li J, Sarosi PM, Shen C, Wang Y, Mills MJ, "Microtwinning and Other Shearing Mechanisms at Higher Temperatures in Ni-base Superalloys," *Progress in Materials Science*, 54, (2009), 839-873.
10. Kovarik L, Unocic RR, Li J, Mills MJ, "The Intermediate Temperature Deformation of Ni-base Superalloys: Importance of Reordering," *Journal of Metals*, 61(2), (2009), 42-48.
9. Unocic RR, Viswanathan GB, Sarosi PM, Karthikeyan S, Mills MJ, "Mechanisms of Creep Deformation in Polycrystalline Ni-Base Disk Superalloys," *Materials Science and Engineering A*, 25-32, (2008), 483-484.
8. Unocic RR, Kovarik L, Shen C, Sarosi PM, Wang Y, Li J, Ghosh S, Mills MJ, "Deformation Mechanisms in Ni-base Superalloys at Higher Temperatures," 11th International Symposium on Superalloys (2008), 377-385.

7. Viswanathan GB, Karthikeyan S, Sarosi PM, Unocic RR, Mills MJ, "Microtwinning During Intermediate Temperature Creep of Polycrystalline Ni-Base Superalloys: Mechanisms and Modeling," *Philosophical Magazine*, 86, (29-31), (2006), 4823-4840.
6. Karthikeyan S, Unocic RR, Sarosi PM, Viswanathan GB, Mills MJ, "Modeling Microtwinning During Creep in Ni-based Superalloys," *Scripta Materialia,* 54, (2006), 1157-1162.
5. Sandhage KH, Snyder RL, Mahad G, Allan SH, Cai Y, Dickerson MB, Gaddis CS, Haluska MS, Shian S, Weatherspoon MR, Rapp RA, Unocic RR, Zalar FM, Zhang Y, Hildebrand M, Palenik BP, "Merging Biological Self-assembly with Synthetic Chemical Tailoring: The Potential for 3-D Genetically Engineered Micro/Nano-devices (3-D GEMS)," *International Journal of Applied Ceramic Technology*, 2 (4), (2005), 317-326.
4. Unocic RR, Zalar FM, Sarosi PM, Cai Y, Sandhage KH, "Anatase Assemblies from Algae: Coupling Biological Self-assembly of 3-D Nanoparticle Structures with Synthetic Reaction Chemistry," *Chemical Communications*, 7, (2004), 796-797.
3. Unocic RR, DuPont JN, "Process Efficiency Measurements in the Laser Engineered Net Shaping (LENS™) Process," *Metallurgical and Materials Transactions B: Process Metallurgy and Materials Processing Science,* 35B(1), (2003), 143-152.
2. Unocic RR, DuPont JN, "Composition Control in the Direct Laser-Deposition Process," *Metallurgical and Materials Transactions B: Process Metallurgy and Materials Processing Science*, 34B(4), 2003, 439-445.
1. Dickerson MB, Unocic RR, Guerra KT, Timberlake MJ, Sandhage KH, The fabrication of dense carbide/refractory metal composites of near net shape at modest temperatures by the PRIMA-DCP process, "Innovative Processing and Synthesis of Ceramics, Glasses, and Composites-Ceramics Transactions, 115, 25-31, 2000

Webinar:

1. Physics World 2D Materials Webinar: "Accelerating Discovery with *in situ* Electron Microscopy," November 15, 2018.
2. MRS On Demand Webinar Series: "In situ Electrochemical Scanning Transmission Electron Microscopy of Electrode-Electrolyte Interfaces," September 23, 2020

Selected Invited Presentations on *In situ* Microscopy:

22. "Atomic Engineering of 2D Materials: Insights from In situ S/TEM Experiments, Theory, and Functional Properties," NIST Virtual Workshop: Current Status and Future Perspective of In-Situ Electron Microscopy for Electronic and Quantum Materials, July 13, 2020.
22. "Atomic Engineering of 2D Materials: Insights from In situ S/TEM Experiments, Theory," Gordon Research Conference, Atomically Precise Nanochemistry, Feb 7, 2020.
20. "4D STEM Data Acquisition, Analytics and Functional Materials Property Extraction", MS&T Portland OR, 2019
19. "Multi-modal Characterization Approach to Understand Proton Transport Mechanisms in Solid Oxide Fuel Cells," Microscopy and Microanalysis, Portland OR, August, 2019
18. "Radiolytic Synthesis of Nanostructured Materials using in situ Liquid Cell Microscopy," AVS International Symposium & Exhibit, Long Beach, CA, October 21-26, 2018
17. "Insight into Atomic Scale Transformations in 2D materials using in situ aberration corrected STEM," Accelerating Research with In situ Electron Microscopy Workshop, University of New South Wales, Sydney Australia, September 7, 2018.
16. "Atomic Insight into Frank- van der Merwe Growth Mechanisms in 2D MXenes," International Materials Research Congress, Cancun, Mexico, August 19-24, 2018.
15. "Insight into Atomic Scale Transformations in 2D Materials using in situ Aberration Corrected STEM," Canadian Center for Electron Microscopy, McMaster University, Advanced Electron Microscopy Conference, June 4-5, 2018.
14. "*In situ* Electrochemical STEM as a Platform for Interpreting Electrochemical Phenomena," 232nd Electrochemical Society Meeting, National Harbor, MD, October 2017.
13. "Multi-modal Approach to Understand Proton Transport Mechanisms in Y-doped Barium Zirconate," 254th ACS National Meeting, Washington, DC, August 2017.
12. "Understanding, Controlling, and Utilizing Radiolysis in Liquid Cell Experiments," Pre-meeting Congress, Microscopy and Microanalysis Annual Meeting, St Louis, MO, August 2017.
11. "In situ Nanoscale Imaging and Spectroscopy of Energy Storage Materials," Microscopy and Microanalysis Annual Meeting, St Louis, MO, August 2017.
10. "Role of Atomic Defects in 2D Materials Functionality," Drexel University Symposium on 2D Transition Metal Compounds for Energy Applications, Philadelphia, PA, May 2017.
9. "Data Analytics Applied to Chemical Transformations in Liquids," Microscopy and Microanalysis Annual Meeting, Columbus, OH, July 2016.
8. "*In situ* Liquid S/TEM: Practical Aspects, Challenges, and Opportunities" Microscopy and Microanalysis Annual Meeting, Portland, OR, August 2015. Physical Sciences Tutorial Lectureship
7. "Quantitative Electrochemical Measurements in Electrochemical Cells: Battery Research," In situ electrochemical TEM workshop, Argonne National Laboratory, IL, June, 2014
6. "Application of In situ ec-S/TEM for Energy Storage Research"

The Minerals, Metals, and Materials (TMS) Annual Meeting, San Diego, CA, February 2014.

5. "Advanced In situ ec-S/TEM for Electrochemical Energy Storage Research," The 14th Frontiers of Electron Microscopy in Materials Science (FEMMS) meeting, Lorne, Victoria, Australia, September 2013.
4. "Development and Application of *In Situ* Electrochemical Cell TEM Methods for Electrical Energy Storage Research," 3rd Hitachi Advanced Microscopy Workshop, Hitachi Electron Microscopy (HEMIC) Product Development Centre at the National Institute for Nanotechnology, Edmonton, Canada, June 2013.
3. "Application of *In Situ* Electrochemical Liquid Cells for Electrical Energy Storage Research," Conference on In situ and Correlative Electron Microscopy (CISCEM), Saarbrucken Germany, November 2012.
2. "Coupling EELS/EFTEM Imaging with Environmental Fluid Cell Microscopy," Microscopy and Microanalysis, Phoenix, AZ, August 2012.
1. "The Versatility of *In Situ* Environmental Fluid Cells for Materials Science Research," Materials Science and Technology Conference, Columbus, OH, October 2011.

Select Oral Presentations on *In situ* Microscopy:

19. "Atomic Defects in Graphene and their Role in Proton Transport and Water Desalination," 19th International Microscopy Congress, Sydney, Australia, Sept. 10-14, 2018. ***Best Presentation Award***
18. "Homoepitaxial Growth of 2D Titanium Carbide MXenes," 19th International Microscopy Congress, Sydney, Australia, Sept. 10-14, 2018.
17. "In situ Edge Engineering of two-dimensional transition metal dichalcogenides," 19th International Microscopy Congress, Sydney, Australia, Sept. 10-14, 2018.
16. "Realizing Real-Time Augmented Microscopy and Analysis on the Latest Advanced Scanning Transmission Electron Microscopes," 19th International Microscopy Congress, Sydney, Australia, Sept. 10-14, 2018.
15. "Atomic Scale Edge Engineering in 2D Transition Metal Dichalcogenides," International Materials Research Congress, Cancun, Mexico, August 20, 2018.
14. "Radiolytic Synthesis of Nanostructured Materials from Liquid Phase Precursors," Spring MRS, April 2018.
13. "Directed Materials Transformations using In situ Liquid Cell Microscopy," Fall MRS, November 29, 2016.
12. "Probing Battery Chemistry with in situ ec-S/TEM and Electron Energy Loss Spectroscopy," Spring MRS, May 29, 2016.
11. "Automated and Shaped Controlled Liquid S/TEM," Fall MRS, December 1, 2015.
10. "Ni-Al Oxidation Reaction Processes Studied In situ using MEMS-based Closed Cell Gas Reaction Electron Microscopy Methods," Fall MRS, November 30, 2015.
9. "Automated and Shaped-Controlled Liquid STEM Nanolithography, " Microscopy and Microanalysis Annular Meeting, Portland, OR, 2015.
8. "Synthesis of Nanostructured Materials with In situ and Electrochemical S/TEM," International Conference on Nanoscience and Technology, Vail, CO, 2014.
7. "Correlating Nanoparticle Nucleation and Growth Mechanisms with Cyclic Voltammetry and *in situ* ec-S/TEM Characterization," Spring MRS, San Francisco, CA, 2014.
6. "Tuning Electrodeposition Parameters for Tailored Nanoparticle Size, Shape, and Morphology: An *In Situ* ec-STEM Investigation," Microscopy and Microanalysis Annual Meeting, Hartford, CT 2014.
5. "Quantitative *In Situ* Electrochemical Liquid Cell Characterization of SEI Formation in Lithium Ion Batteries," Microscopy and Microanalysis Annual Meeting, Indianapolis, IN, 2013.
4. "Practical Aspects of In situ Electrochemical Liquid Cell Microscopy," Fall MRS, Boston, MA, 2012.
3. "Use of *in-situ* TEM Characterization to Probe Electrochemical Processes in Li-ion Batteries," Spring MRS, San Francisco, CA, 2011.
2. "*In-situ* TEM Characterization of Electrochemical Processes in Energy Storage Systems," Microscopy and Microanalysis Annual Meeting, Nashville, TN, 2011.
1. "TEM and *In-situ* Liquid Cell Characterization of Copper Nanowire Growth Mechanisms," Microscopy and Microanalysis Annual Meeting, Nashville, TN, 2011.

University Colloquium

3. "*In situ* and *Operando* Scanning Transmission Electron Microscopy in Liquids and Gases," CNMS Ga Tech Visit Chemical and Nanoscale Imaging Workshop Georgia Institute of Technology, January 31, 2017
2. "Revealing Dynamic Materials Transformations in Liquids using in situ Scanning Transmission Electron Microscopy," Georgia Institute of Technology, School of Materials Science and Engineering, July 13, 2016.
1. "Revealing Dynamic Materials Transformations in Liquids using in situ Scanning Transmission Electron Microscopy," University of Kentucky, Department of Chemical and Materials Engineering, May 9, 2016.

Professional Activities: (International Conference and Workshop Organizer)

2020 "Approaching Operando Imaging Of Functional Materials," Microscopy and Microanalysis, Virtual Conference, August 2020. Marc Willinger and Thomas Hansen (Co-organizers)

2018 "Practical Challenges and Opportunities for *In situ/Operando* Microscopy in Liquids and Gases," Pre-meeting Congress, Microscopy and Microanalysis, Baltimore, MD, 2018. Patricia Kooyman and Houlin Xin (Co-organizers)

2017 "*In situ* and *operando* characterization of material processes in liquids and gases," Microscopy and Microanalysis Annual Meeting, St Louis, Missouri, August 2017. Lead Symposium Organizer. Guangwen Zhou and Libor Kovarik (Co-organizers)

2015 "Measuring Materials' Functionalities and Dynamics in Liquid and Gaseous Environments," Pre-meeting congress workshop at the Microscopy and Microanalysis Annual Meeting, Portland, Oregon, August 2015. (Co-organizer with Renu Sharma and Houlin Xin)

2015 "Advances in Transmission Electron Microscopy and Spectroscopy of Energy-Related Materials," Symposium at the Microscopy and Microanalysis Annual Meeting Portland, Oregon, August 2015. (Symposium Co-organizer with Chongmin Wang and Arda Genc)

2015 "Advances in In situ Microscopy" at the 15th Frontiers of Electron Microscopy in Materials Science Lake Tahoe, CA, September 2015. (*In situ* Microscopy Session Co-organizer)

2015 "Beyond Lithium VIII," Oak Ridge National Laboratory, June 2015. (Local Program Committee)

2014 "Advanced Microscopy Workshop" at the Center for Nanophase Materials Science user meeting (August 2014). (Organizer).

2014 "*In situ* Electrochemical TEM" workshop at Argonne National Laboratory, June 2014. (Co-organizer with Lynn Trahey and Katie Jungjohann)

2013 "Electron Microscopy in Liquids and Gases." Pre-meeting congress at the Microscopy and Microanalysis Annual Meeting, Indianapolis IN, August 2013. (Co-organizer with Judy Yang, Renu Sharma and Larry Allard)

ORNL Service and Committee Membership:

2020 NSF Division of Materials Research Reviewer

2019 L.I.V.E. Virtual Career Fair PSD Representative

2018 ORNL/UT-Battelle Awards Committee (for the Distinguished Scientist and Faculty Scientist Category)

2018 HERE Fellowship Review Committee Member (ORNL)

2016-2018 ORNL Laboratory Directed Research and Development SEED Committee Member

2017 U.S. DOE Mission Innovation: Accelerating Breakthrough Innovation in Carbon Capture, Utilization, and Storage. Cross-cut Panelist

2014-2016 Member of the Center of Nanophase Materials Science User Executive Committee (ORNL)

2013-2015 Alvin M. Weinberg Fellowship Committee Member (ORNL)

Professional Society Membership: Materials Research Society (MRS)**,** Microscopy Society of America (MSA), Electrochemical Society (ECS), The Minerals, Metals, and Materials Society (TMS)

Graduate and Postdoctoral Advisors:

Prof. Michael J. Mills, The Ohio State University (PhD/Postdoc Advisor)

Dr. Karren L. More, Oak Ridge National Laboratory (Alvin M. Weinberg Early Career Fellowship Advisor)

Postdoctoral Researcher Advised:

1) Dr. Matthew Boebinger (Oak Ridge National Laboratory 2020- Present)

2) Dr. Sudhajit Misra (Oak Ridge National Laboratory 2020-Present)

3) Dr. Debangshu Mukherjee (Oak Ridge National Laboratory 2018-Present)

4) Dr. Xiahan Sang (Oak Ridge National Laboratory 2015-2018) Now Professor at Wuhan University of Technology

5) Dr. Robert Sacci (Oak Ridge National Laboratory 2013-2015) Co-advised with Nancy Dudney. Now R&D Staff in CSD

Ph.D. Students Advised:

1) Mr. Jilai Ding (Georgia Institute of Technology- Prof. Nazanin Bassiri-Gharb): "Probing ionic conduction mechanisms" ORNL GO! Fellowship

2) Ms. Elizabeth Stricker (Case Western University- Prof. Robert Savinell) (DOE SCGSR Fellowship)

3) Mr. Matthew Drexler (Georgia Institute of Technology- Prof. Faisal Alamgir) (DOE SCGSR Fellowship)

4) Mr. Matthew Boebinger (Georgia Institute of Technology- Prof. Matthew McDowell) (DOE SCGSR Fellowship)

5) Mr. Dennis Chen (Indiana University-Prof. Sara Skrabalak)(DOE SCGSR Fellowship)

6) Mr. Jacob Gutiérrez-Kolar (Michigan Tech- Prof. Reza Shahbazian-Yassar) (HERE Fellowship)

7) Mr. Reed Wittman (University of Tennessee- Prof. Tom Zawodzinski) (Bredesen Center)