

**JOSHUA W. GALLAWAY, PhD**  
Curriculum Vitae

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Northeastern University, Department of Chemical Engineering  
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**RESEARCH INTERESTS**

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In our lab we study mechanisms within complex electrochemical systems. Practical electrochemical systems such as batteries, sensors, and fuel cells are often complex, involving engineered high surface area electrodes, starved electrolyte conditions, phase transformations, and interplay of the two electrodes. For these reasons there are significant deviations from ideal behavior as well as emergent or unexpected phenomena. We seek to understand these to engineer better devices for broad societal benefit, such as enabling the worldwide adoption of sustainable energy. Toward this end we have developed strategies for coupling electrochemical methods with materials synthesis, transport modeling, and operando analysis techniques, often based on high energy X-rays. Low cost and safe battery materials for electrical storage at the scale of the power grid are our primary interest.

**EDUCATION**

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- 2007      **Columbia University**  
Ph.D. Chemical Engineering (*with distinction*)  
Primary area: Electrochemistry  
Dissertation: *Redox Polymer Mediation for Enzymatic Biofuel Cells*  
Thesis advisor: Scott Calabrese Barton
- 2004      **Columbia University**  
M.S. Chemical Engineering  
Thesis: *Methanol Oxidation on High Surface Area Platinum-Ruthenium in the Presence of Oxygen*
- 1997      **Case Western Reserve University**  
B.S.E. Chemical Engineering (*summa cum laude*)

**PROFESSIONAL EXPERIENCE**

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- 2017-present      **Northeastern University**  
*William O. DiPietro Assistant Professor*  
Department of Chemical Engineering  
Complex Electrochemical Systems Laboratory
- 2009-2017      **The City College of New York**  
*Senior Research Associate*  
The CUNY Energy Institute (Sanjoy Banerjee, PI)  
Research description: Development of low cost and sustainable rechargeable batteries for grid scale electrical storage
- 2010-2017      **New York University Tandon School of Engineering**  
*Adjunct Professor*  
Department of Chemical Engineering
- 2007-2009      **Columbia University**  
*Postdoctoral Fellow*  
Department of Chemical Engineering (Alan West, PI)  
Research description: Development of microfluidic electrochemical devices for analysis of Cu electrodeposition for semiconductor fabrication

## PROFESSIONAL AFFILIATIONS

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|--------------|---|
| 2006-present | <b>The Electrochemical Society</b><br>Battery Division, <i>Member-At-Large</i> (2018-present) |
| 2008-present | <b>American Chemical Society</b>  |
| 2009-present | <b>Materials Research Society</b>   |
| 2009-present | <b>American Institute of Chemical Engineers</b>   |

## AWARDS AND HONORS

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|            |  |
|------------|--|
| 2019       | <b>Dr. R. H. Sioui Award for Excellence in Teaching</b> , Northeastern University  |
| 2019       | <b>EPA Green Chemistry Challenge Award</b>   |
| 2017       | <b>DiPietro Assistant Professorship</b> , Northeastern University                  |
| 2010       | <b>Electrochemical Society Battery Division Early Career Travel Award</b>          |
| 2009       | <b>Wallis Foundation Fellowship for Energy Research</b> , City College of New York |
| 2002, 2003 | <b>Teaching Assistant Award</b> , Columbia University                              |
| 1997       | <b>Kennedy Award for Writing</b> , Case Western Reserve University                 |

## PEER-REVIEWED PUBLICATIONS

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30. Bruck, A.M.; Kim, M.A.; Ma, L.; Ehrlich, S.N.; Okasinski, J.S.; and **Gallaway, J.W.**, "Bismuth Enables the Formation of Disordered Birnessite in Rechargeable Alkaline Batteries." *Journal of the Electrochemical Society*, **2020**, *167*, 110514. DOI:10.1149/1945-7111/aba075
29. Marschilok, A. C.; Bruck, A.; Abraham, A.; Stackhouse, C.; Takeuchi, K. J.; Takeuchi, E. S.; Croft, M.; **Gallaway, J.W.**, "Energy dispersive X-ray diffraction (EDXRD) for operando materials characterization within batteries." *Physical Chemistry Chemical Physics*, **2020**. DOI:10.1039/D0CP00778A
28. **Gallaway, J. W.**; Yadav, G. G.; Turney, D. E.; Nyce, M.; Huang, J.; Chen-Wiegart, Y.-C. K.; Williams, G.; Thieme, J.; Okasinski, J. S.; Wei, X.; Banerjee, S., "An Operando Study of the Initial Discharge of Bi and Bi/Cu Modified MnO<sub>2</sub>." *Journal of the Electrochemical Society*, **2018**, *165* (13), A2935-A2947. DOI:10.1149/2.0221813jes
27. Yadav, G. G.; Wei, X.; **Gallaway, J. W.**; Chaudhry, Z.; Shin, A.; Huang, J.; Yakobov, R.; Nyce, M.; Vanderklaauw, N.; Banerjee, S., "Rapid electrochemical synthesis of  $\delta$ -MnO<sub>2</sub> from  $\gamma$ -MnO<sub>2</sub> and unleashing its performance as an energy dense electrode." *Materials Today Energy*, **2017**, *6* (Supplement C), 198-210. DOI:10.1016/j.mtener.2017.10.008.
26. Huang, J.; Yadav, G. G.; **Gallaway, J. W.**; Wei, X.; Nyce, M.; Banerjee, S., "A calcium hydroxide interlayer as a selective separator for rechargeable alkaline Zn/MnO<sub>2</sub> batteries." *Electrochemistry Communications*, **2017**, *81*, 136-140.
25. Turney, D. E.; **Gallaway, J. W.**; Yadav, G. G.; Ramirez, R.; Nyce, M.; Banerjee, S.; Chen-Wiegart, Y. C. K.; Wang, J.; D'Ambrose, M. J.; Kolhekar, S.; Huang, J. C.; Wei, X., "Rechargeable Zinc Alkaline Anodes for Long-Cycle Energy Storage." *Chemistry of Materials*, **2017**, *29* (11), 4819-4832. DOI:10.1021/acs.chemmater.7b00754
24. Yadav, G. G.; Wei, X.; Huang, J.; **Gallaway, J. W.**; Turney, D. E.; Nyce, M.; Secor, J.; Banerjee, S., "A conversion-based highly energy dense Cu<sup>2+</sup> intercalated Bi-birnessite/Zn alkaline battery." *Journal of Materials Chemistry A*, **2017**, *5* (30), 15845-15854. DOI:10.1039/c7ta05347a.
23. Yadav, G. G.; **Gallaway, J. W.**; Turney, D. E.; Nyce, M.; Huang, J.; Wei, X.; Banerjee, S., "Regenerable Cu-intercalated MnO<sub>2</sub> layered cathode for highly cyclable energy dense batteries." *Nature Communications*, **2017**, *8*, 14424. DOI:10.1038/ncomms14424
22. **Gallaway, J. W.**; Hertzberg, B. J.; Zhong, Z.; Croft, M.; Turney, D. E.; Yadav, G. G.; Steingart, D. A.; Erdonmez, C. K.; Banerjee, S., "Operando identification of the point of [Mn<sub>2</sub>]O<sub>4</sub> spinel formation during gamma-MnO<sub>2</sub> discharge within batteries." *Journal of Power Sources*, **2016**, *321*, 135-142.

DOI:10.1016/j.jpowsour.2016.05.002

21. Ingale, N. D.; **Gallaway, J. W.**; Nyce, M.; Couzis, A.; Banerjee, S., "Rechargeability and economic aspects of alkaline zinc-manganese dioxide cells for electrical storage and load leveling." *Journal of Power Sources*, **2015**, 276, 7-18. DOI:10.1016/j.jpowsour.2014.11.010
20. **Gallaway, J. W.**; Menard, M.; Hertzberg, B.; Zhong, Z.; Croft, M.; Sviridov, L. A.; Turney, D. E.; Banerjee, S.; Steingart, D. A.; Erdonmez, C. K., "Hetaerolite Profiles in Alkaline Batteries Measured by High Energy EDXRD." *Journal of the Electrochemical Society*, **2015**, 162 (1), A162-A168. DOI:10.1149/2.0811501jes
19. Bhadra, S.; Hertzberg, B. J.; Hsieh, A. G.; Croft, M.; **Gallaway, J. W.**; Van Tassell, B. J.; Chamoun, M.; Erdonmez, C.; Zhong, Z.; Sholklapper, T.; Steingart, D. A., "The relationship between coefficient of restitution and state of charge of zinc alkaline primary LR6 batteries." *Journal of Materials Chemistry A*, **2015**, 3 (18), 9395-9400. DOI:10.1039/c5ta01576f.
18. **Gallaway, J. W.**; Erdonmez, C. K.; Zhong, Z.; Croft, M.; Sviridov, L. A.; Sholklapper, T. Z.; Turney, D. E.; Banerjee, S.; Steingart, D. A., "Real-time materials evolution visualized within intact cycling alkaline batteries." *Journal of Materials Chemistry A*, **2014**, 2 (8), 2757-2764. DOI:10.1039/C3TA15169G
17. **Gallaway, J. W.**; Gaikwad, A. M.; Hertzberg, B.; Erdonmez, C. K.; Chen-Wiegart, Y. C. K.; Sviridov, L. A.; Evans-Lutterodt, K.; Wang, J.; Banerjee, S.; Steingart, D. A., "An In Situ Synchrotron Study of Zinc Anode Planarization by a Bismuth Additive." *Journal of the Electrochemical Society*, **2014**, 161 (3), A275-A284. DOI:10.1149/2.037403jes
16. Turney, D. E.; Shmukler, M.; Galloway, K.; Klein, M.; Ito, Y.; Sholklapper, T.; **Gallaway, J. W.**; Nyce, M.; Banerjee, S., "Development and testing of an economic grid-scale flow-assisted zinc/nickel-hydroxide alkaline battery." *Journal of Power Sources*, **2014**, 264, 49-58. DOI:10.1016/j.jpowsour.2014.04.067
15. Gaikwad, A. M.; **Gallaway, J. W.**; Desai, D.; Steingart, D. A., "Electrochemical-Mechanical Analysis of Printed Silver Electrodes in a Microfluidic Device." *Journal of the Electrochemical Society*, **2011**, 158 (2), A154-A162.
14. **Gallaway, J. W.**; Desai, D.; Gaikwad, A.; Corredor, C.; Banerjee, S.; Steingart, D., "A Lateral Microfluidic Cell for Imaging Electrodeposited Zinc near the Shorting Condition." *Journal of the Electrochemical Society*, **2010**, 157 (12), A1279-A1286.
13. von Gutfeld, R. J.; **Gallaway, J. W.**; West, A. C., "In Situ Immersion Plating of Copper and Nickel on Aluminum Using Laser Pulses for Oxide Removal." *Journal of the Electrochemical Society*, **2009**, 156 (12), D564-D569.
12. **Gallaway, J. W.**; Willey, M. J.; West, A. C., "Copper Filling of 100 nm Trenches Using PEG, PPG, and a Triblock Copolymer as Plating Suppressors." *Journal of the Electrochemical Society*, **2009**, 156 (8), D287-D295.
11. **Gallaway, J. W.**; West, A. C., "The effect of acid on superconformal filling in 100 nm trenches." *Journal of Vacuum Science & Technology B*, **2009**, 27 (5), 2200-2205.
10. Hudak, N. S.; **Gallaway, J. W.**; Barton, S. C., "Formation of mediated biocatalytic cathodes by electrodeposition of a redox polymer and laccase." *Journal of Electroanalytical Chemistry*, **2009**, 629 (1-2), 57-62.
9. **Gallaway, J. W.**; Willey, M. J.; West, A. C., "Acceleration Kinetics of PEG, PPG, and a Triblock Copolymer by SPS during Copper Electroplating." *Journal of the Electrochemical Society*, **2009**, 156 (4), D146-D154.
8. Hudak, N. S.; **Gallaway, J. W.**; Barton, S. C., "Mediated Biocatalytic Cathodes Operating on Gas-Phase Air and Oxygen in Fuel Cells." *Journal of the Electrochemical Society*, **2009**, 156 (1), B9-B15.
7. **Gallaway, J. W.**; Barton, S. A. C., "Effect of redox polymer synthesis on the performance of a

- mediated laccase oxygen cathode." *Journal of Electroanalytical Chemistry*, **2009**, 626 (1-2), 149-155.
6. Wheeldon, I. R.; **Gallaway, J. W.**; Barton, S. C.; Banta, S., "Bioelectrocatalytic hydrogels from electron-conducting metallopolypeptides coassembled with bifunctional enzymatic building blocks." *Proceedings of the National Academy of Sciences of the United States of America*, **2008**, 105 (40), 15275-15280.
  5. **Gallaway, J. W.**; West, A. C., "PEG, PPG, and their triblock copolymers as suppressors in copper electroplating." *Journal of the Electrochemical Society*, **2008**, 155 (10), D632-D639.
  4. **Gallaway, J. W.**; Barton, S. A. C., "Kinetics of redox polymer-mediated enzyme electrodes." *Journal of the American Chemical Society*, **2008**, 130 (26), 8527-8536. DOI:10.1021/ja0781543
  3. **Gallaway, J. W.**; Wheeldon, I.; Rincon, R.; Atanassov, P.; Banta, S.; Barton, S. C., "Oxygen-reducing enzyme cathodes produced from SLAC, a small laccase from *Streptomyces coelicolor*." *Biosensors & Bioelectronics*, **2008**, 23 (8), 1229-1235.
  2. Barton, S. C.; Deng, W.; **Gallaway, J. W.**; Levendovsky, S.; Olson, T.; Atanassov, P.; Sorkin, M.; Kaufman, A.; Gibbard, H. F., "Mixed-feed direct methanol fuel cell: Materials and design solutions." *ECS Transactions*, **2006**, 1 (6), 315-322.
  1. Barton, S. C.; **Gallaway, J. W.**; Atanassov, P., "Enzymatic biofuel cells for Implantable and microscale devices." *Chemical Reviews*, **2004**, 104 (10), 4867-4886.

#### BOOK CHAPTERS

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3. **Gallaway, J. W.** and Barton, S. C., "Redox hydrogels as an efficient strategy for immobilization of enzymes at electrode interfaces" Chapter 7, in *Functional Electrodes for Enzymatic and Microbial Bioelectrochemical Systems*, Edited by Victoria Flexer and Nicolas Brun. World Scientific, **2017**.
2. **Gallaway, J. W.**, "Mediated Enzyme Electrodes" Chapter 9, in *Enzymatic Fuel Cells: From Fundamentals to Applications*, Edited by Heather R. Luckarift, Plamen B. Atanassov, and Glenn R. Johnson. John Wiley & Sons, Inc., **2014**.
1. **Gallaway, J. W.** and West, A. C., "Bioelectrochemical Sensors" Chapter 11, in *Electrochemistry and Electrochemical Engineering: An Introduction* by Alan C. West, **2012**.

#### PATENTS

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4. *Mixed Material Cathode For Secondary Alkaline Batteries*. Yadav, G.G.; **Gallaway, J.W.**; Nyce, M.; Banerjee, S., United States patent US 10,276,860 B2, issued April 30, **2019**.
3. *Mixed Material Cathode For Secondary Alkaline Batteries*. Yadav, G.G.; **Gallaway, J.W.**; Nyce, M.; Banerjee, S., United States patent US 10,199,639 B2, issued February 5, **2019**.
2. *Alkaline Battery Operational Methodology*, Sholklipper, T.; **Gallaway, J.W.**; Steingart, D.; Ingale, N.; and Nyce, M. United States patent US 9,419,289 B2, issued August 16, **2016**.
1. *Nickel-Zinc Flow Battery*, Banerjee, S.; Ito, Y.; Klein, M.; Nyce, M.E.; Steingart, D.; Plivelich, R.; **Gallaway, J.W.**, United States patent US 9,379,373 B2, issued June 28, **2016**.

#### PATENT APPLICATIONS

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2. *Rechargeable Alkaline Manganese Dioxide-Zinc Bipolar Batteries*. Yadav, G.G.; Nyce, M.; Wei, X.; Yakobov, R.; **Gallaway, J.W.**; Banerjee, S., US 2019/0044129 A1, Pub. date 7 Feb 2019.
1. *Rechargeable Alkaline Battery Comprising Metal Hydroxide Separator*. Huang, J.; Yadav, G.G.; **Gallaway, J.W.**; Nyce, M.; Banerjee, S., US 2019/0088915 A1, Pub. date 21 Mar 2019.

## SELECTED CONFERENCE PRESENTATIONS

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27. Zhang, Q.; Stavola, A. (poster presenter); Aurora, P.; **Gallaway, J.W.** "Enhanced Electrochemical Stability of NCM811 Solid-State Batteries by Surface Altering Processes" EN02.19.79 Materials for High-Energy and Safe Electrochemical Energy Storage, Materials Research Society Fall Meeting, Boston MA, December **2019**.
26. **Gallaway, J.W.** (speaker), Banerjee, S.; Yadav, G.G.; and Turney, D.E. "Operando Studies to Enumerate the Electrochemical Phase Transformations of MnO<sub>2</sub>" 1E - Electrochemical Fundamentals, American Institute of Chemical Engineers Fall Meeting, Orlando FL, November **2019**.
25. **Gallaway, J.W.** (speaker, **Invited talk**) "Operando Characterization of Rechargeable Alkaline MnO<sub>2</sub> Batteries" AIChE Center for Energy Initiatives, 2019 Battery and Energy Storage Workshop, New York NY, 22 October **2019**.
24. Kim, M. (poster presenter); Jadhav, A.; Hawkins, B.E.; Messinger, R.; Okasinski, J.; and **Gallaway, J.W.** "Operando Energy Dispersive X-Ray Diffraction (EDXRD) of Bulk Cathode Material for Multivalent Secondary Batteries" The Electrochemical Society 236th Meeting, Atlanta GA, Oct **2019**.
23. Bruck, A.M. (poster presenter); Kim, M.; and **Gallaway, J.W.** "Operando Investigations of Bismuth Additives on the Rechargeability of MnO<sub>2</sub> in Alkaline Batteries" US Department of Energy Office of Electricity Peer Review, Albuquerque NM, Sept **2019**.
22. Howell, B.R. (speaker) and **Gallaway, J.W.** "The Electrochemistry of Low-Temperature Molten Quinones for All-Organic Redox Flow Batteries" The Electrochemical Society 235th Meeting, Dallas TX, May **2019**.
21. **Gallaway, J.W.** (speaker); Kim, M.; Jadhav, A.; Messinger, R.; Okasinski, J. "Discharge Reactions of  $\gamma$ -MnO<sub>2</sub> and Mo<sub>6</sub>S<sub>8</sub> Tracked in the Electrode Bulk of Sealed Devices By Energy Dispersive X-Ray Diffraction (EDXRD)" The Electrochemical Society 235th Meeting, Dallas TX, May **2019**.
20. **Gallaway, J.W.** (speaker); Yadav, G.G.; Turney, D.E.; and Banerjee, S. "An Operando Study of Rechargeable MnO<sub>2</sub> Cathodes For Low Cost, High Energy Density Aqueous Batteries" CM03, 2019 Materials Research Society Fall Meeting, Boston MA, November **2018**.
19. **Gallaway, J. W.** (speaker); Yadav, G. G.; Turney, D. E.; Banerjee, S.; Chen-Wiegart, Y.-C. K.; Williams, G.; Thieme, J. "Operando XRF mapping and  $\mu$ -XANES of a Cu-containing Bi-birnessite cathode for high density, low-cost aqueous batteries" 256th American Chemical Society National Meeting, Boston MA, August **2018**.
18. **Gallaway, J.W.** (speaker); Bliznakov, S.; Yadav, G.G.; Turney, D.E.; Ingale, N.; Nyce, M.; Banerjee, S.; Menard, M.; De Angelis, V.; and Couzis, A. "On the Fly EIS Tracking of Rechargeable Alkaline Zn-MnO<sub>2</sub> Batteries for Large-Scale Use" The Electrochemical Society 232nd Meeting, National Harbor MD, October **2017**.
17. **Gallaway, J.W.** (speaker); Yadav, G.G.; Turney, D.E.; Huang, J.; Nyce, M.; Banerjee, S.; Okasinski, J.; Chen-Wiegart, Y.K.; Williams, G.; and Thieme, J. "An Operando Study of Deep-Cycling MnO<sub>2</sub> Cathodes for Low Cost, High Energy Density Aqueous Batteries" The Electrochemical Society 231st Meeting, New Orleans LA, May **2017**.
16. **Gallaway, J.W.** (speaker, **Invited talk**) "Battery Material Characterization as a Bridge From Fundamentals to Applications" 44th American Chemical Society Middle Atlantic Regional Meeting (MARM), 10 June **2016**.
15. **Gallaway, J.W.** (speaker, **Invited talk**); Gaikwad, A.; Sviridov, L.A.; Banerjee, S.; Hertzberg, B.; Steingart, D.A.; Erdonmez, C.K.; Chen-Wiegart, Y.K.; Evans-Lutterodt, and Wang, J.K. "Electrodeposited Zinc Planarized By Bismuth at 3ppm Concentration: A Mechanistic Study" The Electrochemical Society 227th Meeting, Chicago IL, May **2015**.
14. **Gallaway, J.W.** (speaker); Erdonmez, C.K.; Zhong, Z.; Croft, M.; Sviridov, L.A.; Banerjee, S.; and Steingart, D.A. "Transient Interface Evolution in Cycling Alkaline Batteries Resolved Using Synchrotron X-Rays" The Electrochemical Society 224th Meeting, San Francisco CA, October **2013**.
13. **Gallaway, J.W.** (speaker); Erdonmez, C.K.; Zhong, Z.; Croft, M.; Sviridov, L.A.; Banerjee, S.; and

- Steingart, D.A. "Transient Interfacial Zinc Oxide Formation in Cycling Alkaline Batteries Detected Using Synchrotron X-Rays" American Institute of Chemical Engineers Fall Meeting, San Francisco CA, November **2013**.
12. **Gallaway, J.W.** (speaker, **Invited talk**) "Design of Enzyme Electrodes for Sensing and Power Applications" Fundamentals of Electrode and Cell Designs: A Tutorial Session AIChE Fall Meeting, Pittsburgh PA, November **2012**.
  11. **Gallaway, J.W.** (speaker); Erdonmez, C.K.; Sviridov, L.A.; Gaikwad, A.; Shoklapper, T.; Ingale, N.; Nyce, M.; Hertzberg, B.; Banerjee, S.; and Steingart, D.A. "Phase Changes in Secondary Manganese Dioxide Electrodes for Grid-Scale Batteries" American Institute of Chemical Engineers Fall Meeting, Pittsburgh PA, November **2012**.
  10. **Gallaway, J.W.** (speaker); Ingale, N.; Nyce, M.; Ito, Y.; Sviridov, L.; Gaikwad, A.; Lever, S.; Firouzi, A.; Banerjee, S.; and Steingart, D. "Secondary Manganese Dioxide Electrodes for Grid-Scale Batteries" American Institute of Chemical Engineers Fall Meeting, Minneapolis MN, October **2011**.
  9. **Gallaway, J.W.** (poster presenter) "Electrochemistry for Energy: Air-Breathing Enzymatic Electrodes for Batteries and Fuel Cells" American Institute of Chemical Engineers Fall Meeting, Minneapolis MN, October **2011**.
  8. **Gallaway, J.W.** (speaker); Ingale, N.; Nyce, M.; Ito, Y.; Sviridov, L.; Gaikwad, A.; Lever, S.; Firouzi, A.; Banerjee, S.; and Steingart, D. "Cycle Life of Manganese Dioxide Electrodes for Grid-Scale Batteries" The Electrochemical Society 220th Meeting, Boston MA, October **2011**.
  7. **Gallaway, J.W.** (speaker); Shojaei-Zadeh, S.; Gaikwad, A.; and Steingart, D. "Electrochemical and Optical Monitoring of Metal Electrodeposition Interfaces in a Microfluidic Cell" 2010 Materials Research Society Fall Meeting, Boston MA, December **2010**.
  6. **Gallaway, J.W.** (speaker); Ito, Y.; Desai, D.; Nyce, M.; Banerjee, S.; and Steingart, D. "Zinc Layer Current Distribution in Secondary Zinc Metal Batteries for Grid Scale Electrical Storage" The Electrochemical Society 218th Meeting, Las Vegas NV, October **2010**.
  5. **Gallaway, J.W.** (speaker); Shojaei-Zadeh, S.; and Steingart, D. "Microfluidic Electrochemistry: A Versatile Platform to Study Reactions at Electrodes" American Institute of Chemical Engineers Fall Meeting, Nashville TN, November **2009**.
  4. **Gallaway, J.W.** (speaker); Willey, M.J.; and West, A.C. "PEG, PPG, and Their Triblock Copolymers as Suppressors in Copper Electroplating" The Electrochemical Society 214th Meeting, Honolulu HI, Oct. **2008**.
  3. **Gallaway, J.W.** (speaker) and Calabrese Barton, S.A. "High Performance Redox Polymer Films for Enzymatic Electrodes" The Electrochemical Society 212th Meeting, Washington DC, Oct. **2007**.
  2. **Gallaway, J.W.** (speaker) and Calabrese Barton, S.A. "Structure-Function Relationships in Redox Polymer-Enzyme Films for Biofuel Cell Applications" The Electrochemical Society 210th Meeting, Cancun, Mexico, Oct. **2006**.
  1. **Gallaway, J.W.** (poster presenter) and Calabrese Barton, S.A. "Methanol Oxidation on High Surface Area Platinum-Ruthenium in the Presence of Oxygen" The Electrochemical Society 208th Meeting, Los Angeles CA, Oct. **2005**.

#### **SEMINARS AND INVITED PRESENTATIONS**

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11. **Gallaway, J.W.** "Rechargeable Alkaline MnO<sub>2</sub> Batteries for Low Cost & Safe Grid Storage In situ & Operando Characterization of MnO<sub>2</sub>" MIT Lincoln Laboratory, Advanced Materials and Microsystems Group, Lexington MA, 30 August **2019**.
10. **Gallaway, J.W.** "Electrochemistry as Chemical Engineering: A Report From the Front Lines of Sustainability" American Institute of Chemical Engineers Boston, Guppy Night, Boxborough MA, 9 November **2018**.

9. **Gallaway, J.W.** "Rechargeable Alkaline MnO<sub>2</sub> Batteries for Low Cost & Safe Grid Storage In situ & Operando Characterization of MnO<sub>2</sub>" Ionic Materials, Woburn MA, 31 October **2018**.
8. **Gallaway, J.W.** "What makes a successful battery? Managing length scales and hierarchical structures for high energy density, high cycle life, and low cost" Northeastern University Convergence, Boston MA 18 May **2018**.
7. **Gallaway, J.W.** "Operando spectroscopy and diffraction to uncover complex mechanisms in electrochemical devices" National Synchrotron Light Source II Seminar Series, Upton NY, 2 December **2016**.
6. **Gallaway, J.W.** "Safe, Inexpensive, and Energy Dense Alkaline Batteries for the Grid Scale" NIST, Functional Nanostructured Materials Group, Gaithersburg MD, 22 September **2016**.
5. **Gallaway, J.W.** "Batteries for Massive-Scale Electrical Storage: Using New In Situ Techniques for Electrochemical Systems" Stony Brook University, Department of Materials Science, 25 February **2015**.
4. **Gallaway, J.W.** "Batteries for Massive-Scale Electrical Storage: Using New In Situ Techniques for Electrochemical Systems" Michigan State University, Department of Chemical Eng & Materials Sci, 18 September **2014**.
3. **Gallaway, J.W.** "Microscopic, In Situ Monitoring of Electrochemical Processes for Energy Storage Applications" Duracell, Danbury CT, December **2013**.
2. **Gallaway, J.W.** "Microscopic, In Situ Monitoring of Electrochemical Processes for Energy Storage Applications" Power Sources Technology Group, Sandia National Lab, January **2013**.
1. **Gallaway, J.W.** "Biological Catalysis in the Future of Energy: Electrochemistry for the 21st Century" New York Nanoscience Discussion Group, NYU, 11 November **2011**.

## RESEARCH SUPPORT

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### Current support

**US Department of Energy**, Office of Electricity (OE) 9/1/18-12/31/20

**Gallaway, PI:** \$212,704

"Understanding Phase Change Processes of Energy Storage Materials"

This project aims to understand phase changes in battery active materials that occur during cycling, especially in cases where there are mixtures of intercalation and conversion reactions occurring in the same material. We will make use of highly penetrating operando experiments such as energy dispersive X-ray diffraction (EDXRD).

**National Science Foundation**, CBET, Electrochemical Systems 9/1/19-8/31/22

Hongli Zhu, PI: \$479,717 (**Gallaway:** \$239,858)

"Engineering the Metal Sulfide Interface in All Solid State Batteries through Operando Study"

This project aims to improve metal sulfide stability in solid-state electrolytes for the application of all solid-state lithium batteries. In pursuit of this objective, the fundamental mechanisms of metal sulfide ion conduction and interface reactivity will be interrogated by operando characterization carried out on realistic, fully operational battery cells.

**US Department of Defense**, Army CCDC 1/1/20-12/31/20

**Gallaway, PI:** \$149,857

"Solid Polymer Electrolytes for High Energy Density Li-ion Batteries"

This project aims to develop high energy density Li-ion batteries using non-flammable solid electrolytes by additive manufacturing.

**NASA MUREP Institutional Research Opportunity (MIRO)** 9/1/19-8/31/22

Robert Messinger (CCNY), PI: \$3,000,000 (**Gallaway:** \$110,696)

"NASA-CCNY Center for Advanced Batteries for Space (ABS)"

In addition to designing hi-tech batteries that will significantly enhance the scope and ambition of future NASA planetary science missions, CCNY and its partners will establish a multi-faceted student internship program between CCNY and JPL, a student exchange program between CCNY and Northeastern University, and an undergraduate summer research program at CCNY.

**Northeastern University**, DiPietro Assistant Professorship 9/1/17-8/31/22  
**Gallaway, PI: \$75,000**

### **Completed support**

Northeastern University, FY19 TIER 1 Award 5/1/18-9/30/19  
**Gallaway, PI: \$50,000**

"A Dense Anthraquinone-Based Ionic Liquid For Grid-Scale Electrical Storage"

This seed project aims to develop a series of quinone-based ionic liquids that remain redox-active in the undiluted or neat state. These materials will be appropriate for active materials in redox flow batteries (RFBs) for backing up intermittent renewable power generation.

### **COURSES TAUGHT**

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2017-present **Northeastern University**  
CHME 5621 Electrochemical Engineering (Sp 2020, Enrollment: 20)  
CHME 2308 Conservation Principles (Sp 2020, Enrollment: 60)  
CHME 2308 Conservation Principles (Fa 2019, Enrollment: 19)  
CHME 5621 Electrochemical Engineering (Sp 2019, Enrollment: 33), **new course**  
CHME 2308 Conservation Principles (Sp 2019, Enrollment: 53)  
CHME 2308 Conservation Principles (Fa 2018, Enrollment: 19)  
CHME 2308 Conservation Principles (Sp 2018, Enrollment: 48)  
CHME 2308 Conservation Principles (Fa 2017, Enrollment: 42)

2010-2017 **New York University Tandon School of Engineering**  
CBE-UY 3313 Transport Phenomena I (Taught 7 semesters, Total enrollment: 360)  
CBE-UY 3323 Transport Phenomena II (Taught 7 semesters, Total enrollment: 351)

2010 **The City College of New York**  
ENGR 23000 Thermodynamics (Su 2010, Enrollment: 21)

### **RESEARCH SUPERVISION**

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#### **Northeastern University (postdoctoral)**

**Dr. Andrea Bruck** (2019-present)

Project: "Operando Investigations of the Rechargeability of MnO<sub>2</sub> in Alkaline Batteries "  
Postdoctoral Research Associate, Chemical Engineering, Northeastern University

**Dr. Qing Zhang** (2019)

Project: "Enhanced electrochemical stability of NCM811 solid-state batteries by surface altering processes"  
Postdoctoral Research Associate, Kostas Research Institute, Northeastern University

#### **Northeastern University (graduate)**

**Alyssa Stavola** (2018-present)

Thesis Project: "Tracking Battery State of Health by Electrochemical Impedance Spectroscopy"  
PhD, Chemical Engineering, Northeastern University, expected 2023

**Matthew Kim** (2017-present)

Thesis Project: "Understanding Phase Change Processes of Energy Storage Materials"  
PhD, Chemical Engineering, Northeastern University, expected 2022

**Benjamin Howell** (2017-present)

Thesis Project: "A Dense Anthraquinone-Based Ionic Liquid For Grid-Scale Electrical Storage"  
PhD, Chemical Engineering, Northeastern University, expected 2022



**Pushkar Gokhale (2018-2020)**

Thesis Title: "Current Distribution In Cylindrical And Prismatic Zinc Anodes"

MS, Chemical Engineering, Northeastern University, 2020

**Zhicheng Lu (2017-2019)**

Thesis Title: "Mathematical Modeling Of The Initial Discharge Of Alkaline Zinc-Manganese Dioxide Batteries"

MS, Chemical Engineering, Northeastern University, 2019

**Northeastern University (undergraduate)**

**Tristan Owen (2017-present)**

Project: "Cycling of Alkaline Batteries"

BS, Chemical Engineering, Northeastern University, expected 2021

**Josie Lee (2019-present)**

Project: "Fabrication of Li-ion Batteries"

BS, Chemical Engineering, Northeastern University, expected 2021

**Sydney Morris (2019-present)**

Project: "A Quality Control Analysis of Li-ion Batteries"

BS, Chemical Engineering, Northeastern University, expected 2021

**James Goulart (2019-present)**

Project: "Coin Cell Fabrication: Standard Operating Protocol V2"

BS, Chemistry, Northeastern University, expected 2021

**Erick Ruoff (2019-present)**

CHME 5984 Research, Fall 2019: "Coin Cell Fabrication: Standard Operating Protocol"

BS, Chemical Engineering, Northeastern University, expected 2021

**Sofia Catalina (2018-2020)**

CHME 4991 Research, Fall 2019: "Development of a Lab-Scale Vanadium Redox Flow Battery"

Northeastern University SSIRF Program, Summer 2019: "Hydrodynamic properties of room temperature ionic liquids for flow batteries"

BS, Chemical Engineering, Northeastern University, 2020

Currently: Stanford University

**Katelyn Ripley (2018-2020)**

CHME 4991 Research, Spring 2020: "CNTs in Bismuth-Modified Manganese Dioxide Cathodes"

EMGT 7978 Research, Fall 2019: "Electrochemical Study on Bismuth-Modified Manganese Dioxide Cathodes"

BS, Chemical Engineering, Northeastern University, 2020

Currently: MIT

**Shakti Katheria (2019)**

REU-POWER Program, Northeastern University, PI: Bradley Lehman

Thesis Project: "Lithium-Ion Batteries with Different Cathode Materials"

MassBay Community College, Electrical and Computer Engineering, 2020

**Nicholas Kamm (2018-2019)**

CHME 4991 Research, Fall 2018: "An Area Specific Impedance Analysis of Blended Cathode Li-ion Batteries"

BS, Chemical Engineering, Northeastern University, 2019

Currently: A123 Systems

**The City College of New York (undergraduate)**

**Raven Bertot (2014-2015)**, visiting student from New York University

Thesis Project: "Measuring Impedance in MnO<sub>2</sub> Cathodes as a Function of State of Charge"

BS, Chemical Engineering, New York University, 2015

**Amy Shin (2015)**, summer student from Herricks High School, New Hyde Park NY

Thesis Project: "Cycling of MnO<sub>2</sub> Electrodes: Influence of Additives on Cell Performance"

Project submitted to Siemens Competition in Math, Science and Technology and Intel STS, 2015

Paper co-author

**Zeeshan Chaudhry (2014-2015)**, visiting student from New York University

Thesis Project: "Incorporating Multiwalled Carbon Nanotubes into Birnessite MnO<sub>2</sub> Cathodes"

BS, Chemical Engineering, New York University, 2015

Paper co-author

**Dustin Liu (2014)**, summer student from Herricks High School, New Hyde Park NY

Thesis Project: "Barium Hydroxide as an Electrolyte Additive to Improve Zn/MnO<sub>2</sub> Battery Performance"

Project submitted to Siemens Competition in Math, Science and Technology and Intel STS, 2014

**Desiree Kettell** (2013-2014), visiting student from New York University  
Thesis Project: "Barium Compounds as Additives in Shallow-Cycled MnO<sub>2</sub> Batteries"  
BS, Chemical Engineering, New York University, 2014

**Jerome Fineman** (2011-2013), visiting student from New York University  
Thesis Project: "The Effect of Bi on Ni-Zn Batteries with Electrolyte Under Forced Convection"  
BS, Chemical Engineering, New York University, 2013

## **Northeastern University COMMITTEE SERVICE**

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### **MS and PhD Committees**

**Li Jiao**, PhD (CHME), Northeastern University (Sanjeev Mukerjee, Advisor), expected 2021  
**Ankur Jadhav**, PhD (Chem Eng), The City College of New York (Rob Messinger, Advisor), expected 2020  
**Sawan Karumbaiah Koopadira**, MS (CHME), Northeastern University (Sanjeev Mukerjee, Advisor), 2019  
**Javier Fonseca**, PhD (CHME), Northeastern University (Sunho Choi, Advisor), 2020  
**Ehsan Keyvani-Someh**, PhD (CHME), Northeastern University (Hicham Fenniri, Advisor), 2019  
**Martin Kimani**, PhD (CHME), Northeastern University (Edgar Goluch, Advisor), 2019  
**Huong Doan**, PhD (CHEM), Northeastern University (Sanjeev Mukerjee, Advisor), 2019  
**Wenjun Zheng**, MS (CHME), Northeastern University (Ming Su, Advisor), 2018  
**Haotian Zhang**, MS (CHME), Northeastern University (Ming Su, Advisor), 2018  
**Deyang Li**, PhD (CHME), Northeastern University (Elizabeth Podlaha-Murphy, Advisor), 2018  
**Miguel Angel Alvarez Sanchez**, MS (CHME), Northeastern University (Thomas Webster, Advisor), 2018  
**Priyanka Satpute**, MS (CHME), Northeastern University (Richard West, Advisor), 2018

### **Northeastern University Committees**

**Graduate Committee**, Dept. of Chemical Engineering, Member (2017-present)  
**Graduate Student Council**, Dept. of Chemical Engineering, Co-advisor (2018-present)  
**Curriculum Review Committee**, Dept. of Chemical Engineering, Member (2017-2018)

## **PROFESSIONAL SERVICE**

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### **Ad hoc manuscript reviews**

Journal of the Electrochemical Society (25)  
Journal of Power Sources (19)  
ECS Electrochemistry Letters (4)  
Materials Chemistry and Physics (4)  
Joule (3)  
Energy Storage Materials (2)  
Advanced Functional Materials (1)  
Chem (1)  
ECS Solid State Letters (1)  
Electroanalysis (1)  
Energy Storage Technologies (1)  
Journal of Alloys and Compounds (1)  
Journal of the American Chemical Society (1)  
Journal of Applied Electrochemistry (1)  
The Journal of Physical Chemistry (1)  
Nature Communications (1)  
npj Materials Degradation (1)  
RSC Advances (1)  
Scientific Reports (1)

### **Symposium Organizer**

2. Co-organizer, Materials Research Society, EN05 Low-Cost Aqueous Rechargeable Battery Technologies (Spring 2020, postponed due to COVID-19)

1. **Lead Organizer**, The Electrochemical Society, A01 Battery and Energy Technology Joint General Session (Fall 2019)

### **Panel Speaker**

2. **Discussion Leader**, "Modes of Failure: What Is Killing My System Now?" Batteries Gordon Research Conference (GRC), Ventura CA, Feb 20, 2020.
1. Moderator, "Energy Storage For The Modern Age," 5th Annual Energy Conference, Northeastern University, Sept 27, 2019.

### **Session Chair**

The Electrochemical Society (Fa 2019, Sp 2018, Sp 2016)  
Materials Research Society (Fa 2018)

### **Editorial Work**

*ECS Interface*, Tech Highlights writer (2019-present)

### **Proposal Reviews**

DOE, NSF

## **EDUCATIONAL OUTREACH**

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### **Multimedia Outreach**

4. "Storing Electricity with Batteries." A demonstration program to introduce high school students to the science and engineering of batteries. Run with the Northeastern University Center for STEM Education at these times:  
**Jun 2019**, for Young Scholars Program  
**Nov 2018**, for Building Bridges Program
3. "Why It's So Hard To Make Better Batteries: Crash Course Engineering #32." Video about the engineering of batteries for the PBS series Crash Course. Technical content written with Lucas Landherr. Published **17 Jan 2019**. Views (as of Jan 18, 2020): 96,291. <https://www.youtube.com/watch?v=A5GgBTFSUu4>
2. "Citrus Battery." Narration accompanied by animation, from the television show *Duck Quacks Don't Echo*, National Geographic Channel. Original air date **20 Jan 2014**. <https://www.youtube.com/watch?v=DnB0sFrYtrU>
1. *Clear Science!* A science blog geared to high school students. "Clear Science is dedicated to straightforward science lessons in plain English everyone can understand." 130,000 followers in 2013. Active **2010-2013**. <https://clearscience.tumblr.com>

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