

The Electrocatalysis Consortium (ElectroCat)

2016-2020

Publications

1. "Novel platinum group metal-free catalyst ink deposition system for combinatorial polymer electrolyte fuel cell performance evaluation;" J. Park and D. Myers, *J. Power Sources*, **480**, 228801 (2020). doi:10.1016/j.jpowsour.2020.228801.
2. "Coupling High-Throughput Experiments and Regression Algorithms to Optimize PGM-Free ORR Electrocatalyst Synthesis;" M. Karim, M. Ferrandon, S. Medina, E. Sture, N. Kariuki, D.J. Myers, E.F. Holby, P. Zelenay, and T. Ahmed, *ACS Appl. Energy Mater.*, (2020). doi:10.1021/acsaem.0c01466.
3. "Status and Challenges for the Application of Platinum Group Metal-Free Catalysts in Proton Exchange Membrane Fuel Cells;" L. Osmieri, J. Park, D.A. Cullen, P. Zelenay, D.J. Myers, K. C. Neyerlin, *Curr. Opin. Electrochem.*, (2020). doi:10.1016/j.coelec.2020.08.009.
4. "Single-Iron Site Catalysts with Self-Assembled Dual-size Architecture and Hierarchical Porosity for Proton-Exchange Membrane Fuel Cells;" X. Zhao, X. Yang, M. Wang, S. Hwang, S. Karakalos, M. Chen, Z. Qiao, L. Wang, B. Liu, Q. Ma, D.A. Cullen, D. Su, H. Yang, H.Y. Zang, Z. Feng, G. Wu, *Appl. Catal. B: Environ.*, **279**, 119400 (2020). doi:10.1016/j.apcatb.2020.119400.
5. "Durability evaluation of a Fe-N-C catalyst in polymer electrolyte fuel cell environment via accelerated stress tests;" L. Osmieri, D.A. Cullen, H.T. Chung, R.K. Ahluwalia, K.C. Neyerlin, *Nano Energy*, **78**, 105209-105218 (2020). doi:10.1016/j.nanoen.2020.105209.
6. "Understanding water management in platinum group metal-free electrodes using neutron imaging;" S. Komini Babu, D. Spornjak, R. Mukundan, D.S. Hussey, D. L. Jacobson, H. T. Chung, G. Wu, A. J. Steinbach, S. Litster, R. L. Borup, and P. Zelenay, *J. Power Sources*, **472**, 228442 (2020). doi:10.1016/j.jpowsour.2020.228442.
7. "Utilizing ink composition to tune bulk-electrode gas transport, performance, and operational robustness for a Fe-N-C catalyst in polymer electrolyte fuel cell;" L. Osmieri, G. Wang, F.C. Cetinbas, S. Khandavalli, J. Park, S. Medina, S.A. Mauger, M. Ulsh, S. Pylypenko, D.J. Myers, K.C. Neyerlin, *Nano Energy*, **75**, 104943-104955 (2020). doi:10.1016/j.nanoen.2020.104943.
8. "Preparation of Non-precious Metal Electrocatalysts for the Reduction of Oxygen Using a Low-Temperature Sacrificial Metal;" T. Al-Zoubi, Y. Zhou, X. Yin, B. Janicek, C.-J. Sun, C. Schulz, X. Zhang, A. Gewirth, P. Huang, P. Zelenay, H. Yang, *J. Am. Chem. Soc.*, **142** (12), 5477-5481 (2020). doi:10.1021/jacs.9b11061.
9. "Evolution Pathway from Iron Compounds to Fe₂(II)-N_x Sites through Gas-Phase Iron during Pyrolysis;" J. Li, L. Jiao, E. Wegener, L. L. Richard, El Liu, A. Zitolo, M. T. Sougrati, S. Mukerjee, Z. Zhao, Y. Huang, F. Yang, S. Zhong, H. Xu. A. J. Kropf, F. Jaouen, D. J. Myers, Q. Jia, *J. Am. Chem. Soc.*, **142**, 1417-1423 (2020). doi:10.1038/ncomms8343.
10. "Mass transport characterization of platinum group metal-free polymer electrolyte fuel cell electrodes using a differential cell with an integrated electrochemical sensor;" A. G. Star, G.

Wang, S. Medina, S. Pylypenko, K.C. Neyerlin, *J. Power Sources*, **450** (29), 227655-227664 (2020). doi:10.1016/j.jpowsour.2019.227655.

11. "Improving the bulk gas transport of Fe-N-C platinum group metal-free nanofiber electrodes via electrospinning for fuel cell applications;" S. Kabir, S. Medina, G. Wang, G. Bender, S. Pylypenko, K.C. Neyerlin, *Nano Energy*, **73**, 104791-104802 (2020). doi:10.1016/j.nanoen.2020.104791.
12. "Elucidating the role of ionomer in the performance of platinum group metal-free catalyst layer via in situ electrochemical diagnostics;" G. Wang, L. Osmieri, A. G. Star, J. Pfeilsticker, K.C. Neyerlin, *J. Electrochem. Soc.*, **167**, 044519-044527 (2020). doi:10.1149/1945-7111/ab7aa1.
13. "Use of a segmented cell for the combinatorial development of platinum group metal-free electrodes for polymer electrolyte fuel cells;" L. Osmieri, S. Mauger, M. Ulsh, K.C. Neyerlin, G. Bender, *J. Power Sources*, **452**, 227829-227840 (2020). doi:10.1016/j.jpowsour.2020.227829.
14. "X-ray photoelectron spectroscopy and rotating disk electrode measurements of smooth sputtered Fe-N-C films;" Y. Xu, M.J. Dzara, S. Kabir, S. Pylypenko, K. Neyerlin, A. Zakutayev, *Appl. Surf. Sci.*, **515**, 146012-146018 (2020). doi:10.1016/j.apsusc.2020.146012.
15. "Thermally Driven Structure and Performance Evolution of Atomically Dispersed FeN₄ Sites for Oxygen Reduction;" J. Li, H. Zhang, W. Samarakoon, W. Shan, D. A. Cullen, S. Karakalos, M. Chen, D. Gu, K. L. More, G. Wang, Z. Feng, Z. Wang, G. Wu, *Angew. Chem. Int. Ed.*, **59**, 18971-18980 (2019). doi: 10.1002/anie.201909312.
16. "Heat-Treated Iron Porphyrin Aerogels for Oxygen Reduction Reaction;" N. Zion, D. A. Cullen, P. Zelenay, L. Elbaz, *Angew. Chem. Int. Ed.*, **58**, 2-9 (2019). doi:10.1002/anie.201913521.
17. "2,2'-Dipyridylamine as Heterogeneous Organic Molecular Electrocatalyst for Two-Electron Oxygen Reduction Reaction in Acid Media;" X. Yin, L. Lin, U. Martinez, P. Zelenay, *ACS Appl. Energy Mater.*, **2**, 7272-7278 (2019). doi:10.1021/acsaem.9b01227.
18. "Resolving Active Sites in Atomically Dispersed Electrocatalysts for Energy Conversion Applications;" D. A. Cullen, K. L. More, K. C. Neyerlin, H. T. Chung, P. Zelenay, D. Myers, *Microsc. Microanal.*, **25** S2, 2066-2067 (2019). doi:10.1017/S1431927619011061.
19. "Elucidation of Fe-N-C electrocatalyst active site functionality via in-situ X-ray absorption and operando determination of oxygen reduction reaction kinetics in a PEFC;" L. Osmieri, R. K. Ahluwalia, X. Wang, H. T. Chung, X. Yin, A. J. Kropf, J. Park, D. A. Cullen, K. L. More, P. Zelenay, D. J. Myers, K. C. Neyerlin, *Appl. Catal. B: Environ.*, **257**, 117929-117941 (2019). doi:10.1016/j.apcatb.2019.117929.
20. "Atomically Dispersed Iron Catalysts for Polymer Electrolyte Fuel Cells;" H. Zhang, H. T. Chung, D. A. Cullen, S. Wagner, U. I. Kramm, K. L. More, P. Zelenay, G. Wu, *Energy Environ. Sci.*, **12**, 2548-2558 (2019).
21. "Highly active atomically dispersed CoN₄ fuel cell cathode catalysts derived from surfactant-assisted MOFs: carbon-shell confinement strategy;" Y. He, S. Hwang, D. A. Cullen, M. A. Uddin, L. Langhorst, B. Li, S. Karakalos, A. J. Kropf, E. C. Wegener, J. Sokolowski, M. Chen, D. Myers, D. Su, K. L. More, G. Wang, S. Litster, G. Wu, *Energy Environ. Sci.*, **12**, 250-260 (2019). doi:10.1039/C8EE02694G.

22. "PGM-free ORR catalysts designed by templating PANI-type polymers containing functional groups with high affinity to iron;" X. Yin, H. T. Chung, U. Martinez, L. Lin, K. Artyushkova, P. Zelenay, *J. Electrochem. Soc.*, **166** (7), F3240-F3245 (2019). doi:10.1149/2.0301907jes.
23. "Experimental and Theoretical Trends of PGM-free Electrocatalysts for the Oxygen Reduction Reaction with Different Transition Metals;" U. Martinez, E. F. Holby, S. Komini Babu, K. Artyushkova, L. Lin, S. Choudhury, P. Zelenay, *J. Electrochem. Soc.*, **166** (7), F3136-F3142 (2019). doi:10.1149/2.0201907jes.
24. "Performance of Polymer Electrolyte Fuel Cell Electrodes with Atomically Dispersed (AD) Fe-C-N ORR Catalyst;" R. K. Ahluwalia, X. Wang, L. Osmieri, J-K Peng, H. T. Chung, and K. C. Neyerlin, *J. Electrochem. Soc.*, **166**, F1096-F1104 (2019). doi:10.1149/2.0851914jes.
25. "Nitrogen-Doped Graphene Oxide Electrocatalysts for the Oxygen Reduction Reaction;" J. H. Dumont, U. Martinez, K. Artyushkova, G. M. Purdy, A. M. Dattelbaum, P. Zelenay, A. Mohite, P. Atanassov, G. Gupta, *ACS Appl. Nano Mater.*, **2**, 1675-1682 (2019). doi:10.1021/acsanm.8b02235.
26. "PGM-free Cathode Catalysts for PEM Fuel Cells: a Mini-Review on Stability Challenges;" Y. Shao, J.-P. Dodelet, G. Wu, P. Zelenay, *Adv. Mater.*, **31**, 1807615-1807615 (2019). doi:10.1002/adma.201807615.
27. "Highly Active Atomically Dispersed CoN_x Fuel Cell Cathode Catalysts Derived from Surfactant-assisted MOFs: Carbon-shell Confinement Strategy;" Y. He, S. Hwang, D.A. Cullen, M.A. Uddin, L. Langhorst, B. Li, S. Karakalos, A.J. Kropf, E.C. Wegener, J. Sokolowski, M. Chen, D. Myers, D. Su, K.L. More, G. Wang, S. Litster, G. Wu, *Energy Environ. Sci.*, **12** (1), 250-260 (2019). doi:10.1039/C8EE02694G.
28. "Progress in the Development of Fe-based PGM-free Electrocatalysts for Oxygen Reduction Reaction;" U. Martinez, S. Komini Babu, E. F. Holby, H. T. Chung, X. Yin, P. Zelenay, *Adv. Mater.*, **31**, 1806545 (2019). doi:10.1002/adma.201806545.
29. "Atomically Dispersed Manganese Catalysts for Oxygen Reduction in Proton-exchange Membrane Fuel Cells;" J. Li, M. Chen, D.A. Cullen, S. Hwang, M. Wang, B. Li, K. Liu, S. Karakalos, M. Lucero, H. Zhang, C. Lei, H. Xu, G.E. Sterbinsky, Z. Feng, D. Su, K. L. More, G. Wang, Z. Wang, G. Wu, *Nat. Catal.*, **1** (12), 935-945 (2019). doi:10.1038/s41929-018-0164-8.
30. "High-performance Oxygen Reduction Reaction Fuel Cell Catalysts Containing Only Atomically Dispersed Iron Active Sites;" H. Zhang, H.T. Chung, D.A. Cullen, S. Wagner, U.I. Kramm, K.L. More, P. Zelenay, G. Wu, *Energy Environ. Sci.*, **12**, 2548-2558 (2019). doi: 10.1039/c9ee00877b
31. "Highly Graphitic Mesoporous Fe,N-doped Carbon Materials for Oxygen Reduction Electrochemical Catalysts;" D. Kim, N.P. Zussblatt, H.T. Chung, S.M. Becwar, P. Zelenay, B.F. Chmelka, *ACS Appl. Mater. Interfaces*, **10**, 25337-25349 (2018). doi:10.1021/acsami.8b06009.
32. "Kinetic Models for the Degradation Mechanism of the PGM-free ORR Catalysts;" X. Yin, P. Zelenay, *ECS Trans.*, **85** (13), 1239-1250 (2018).
33. "Elucidation of Role of Graphene in Catalytic Designs for Electroreduction of Oxygen;" P. J. Kulesza, J. K. Zak, I. A. Rutkowska, B. Dembinska, S. Zoladek, K. Miecznikowski, E. Negro,

- V. Di Noto, P. Zelenay, *Curr. Opin. Electrochem.*, **9**, 257-264 (2018). doi:10.1016/j.coelec.2018.05.012.
34. "Durability Challenges and Perspective in the Development of PGM-free Electrocatalysts;" U. Martinez, S. Komini Babu, E. F. Holby, P. Zelenay, *Curr. Opin. Electrochem.*, **9**, 224-232 (2018). doi:doi.org/10.1016/j.coelec.2018.04.010.
 35. "Metal-organic Framework-derived Nitrogen-doped Highly Disordered Carbon for Electrochemical Ammonia Synthesis using N₂ and H₂O in Alkaline Electrolytes;" S. Mukherjee, D.A. Cullen, S. Karakalos, K. Liu, H. Zhang, S. Zhao, H. Xu, K.L. More, G. Wang, G. Wu, *Nano Energy*, **48**, 217-226 (2018). doi:doi.org/10.1016/j.nanoen.2018.03.059.
 36. "ElectroCat: DOE's Approach to PGM-free Catalyst and Electrode R&D," S.T. Thompson, A.R. Wilson, P. Zelenay, D.J. Myers, K.L. More, K.C. Neyerlin, D. Papageorgopoulos, *Solid State Ionics*, **319**, 68-76 (2018). doi:10.1016/j.ssi.2018.01.030.
 37. "Elucidation of role of graphene in catalytic designs for electroreduction of oxygen;" P. J. Kulesza, J. K. Zak, I. A. Rutkowska, B. Dembinska, S. Zoladek, K. Miecznikowski, E. Negro, V. Di Noto, and P. Zelenay, *Curr. Opin. Electrochem.*, **9**, 257-264 (2018). doi:10.1016/j.coelec.2018.05.012.
 38. "Durability Challenges and Perspective in the Development of PGM-free Electrocatalysts;" U. Martinez, S. Komini Babu, E. F. Holby, and P. Zelenay, *Curr. Opin. Electrochem.*, **9**, 224-232 (2018). doi:10.1016/j.coelec.2018.04.010.
 39. "Nitrogen-coordinated Single Atom Cobalt Sites Derived from Metal Organic Frameworks for High Performance Oxygen Reduction in Acidic Media;" X.X. Wang, D.A Cullen, Y.-T. Pan, S. Hwang, M. Wang, Z. Feng, J. Wang, M.H. Engelhard, H. Zhang, Y. He, Y. Shao, D. Su, K.L More, J.S Spendelow, G. Wu, *Adv. Mater.*, **30**, 217-226 (2018). doi: 10.1002/adma.201706758
 40. "Effects of MEA Fabrication and Ionomer Composition on Fuel Cell Performance of PGM-free ORR Catalyst;" X. Yin, L. Lin, H. T. Chung, S. Komini Babu, U. Martinez, G. M. Purdy, and P. Zelenay, *ECS Trans.*, **77** (11) 1273-1281 (2017). doi:10.1149/07711.1273ecst.
 41. "Direct Atomic-Level Insight into the Active Sites of a High-Performance PGM free ORR Catalyst;" H. T. Chung, D. A. Cullen, D. Higgins, B. T. Sneed, E. F. Holby, K. L. More, and P. Zelenay, *Science*, **357** (6350), 479-484 (2017). doi:10.1126/science.aan2255.
 42. "Modeling Electrochemical Performance of the Hierarchical Morphology of Precious Group Metal-free Cathode for Polymer Electrolyte Fuel Cell;" S. Komini Babu, H. T. Chung, P. Zelenay, and S. Litster, *J. Electrochem. Soc.*, **164** (9), F1037-F1049 (2017). doi:10.1149/2.0041712jes.

Presentations

1. University of Cincinnati Department of Chemistry Colloquium, Cincinnati, Ohio, February 21, 2020. Title: "New opportunities and challenges for hydrogen fuel cells;" D. A. Cullen (**invited lecture**).
2. Telluride Science Research Center (TRSC) Workshop, Platinum Group Metal-free Electrocatalysts: Small Molecules Activation and Conversion, January 21-24, 2020. Title: "PGM-free Electrocatalysis at Crossroads: How to Assure Much Needed Progress?" P. Zelenay (**invited lecture**).

3. Giner Inc. Newton, Massachusetts, December 22, 2019. Title: "Atomic-level insights into fuel cell catalysts;" D. A. Cullen (**invited lecture**).
4. CNMS Seminar Series, Oak Ridge, Tennessee, December 11, 2019. Title: "Atomic-level insights into the next generation of fuel cell catalysts;" D. A. Cullen (**invited lecture**).
5. Royal Institute of Technology (KTH), School of Engineering Sciences in Chemistry, Biotechnology and Health, Stockholm, Sweden, November 4, 2019. Title: "Oxygen Reduction Reaction on Fe-derived Platinum Group Metal-Free Electrocatalysts;" P. Zelenay (**invited lecture**).
6. 4th Israeli Fuel Cell Consortium Workshop, Tel Aviv-Haifa, Israel, October 28-31, 2019. Title: "Durability of Platinum Group Metal-Free Catalysts for Oxygen Reduction: A Formidable Challenge;" P. Zelenay (**invited lecture**).
7. AVS 66th International Symposium & Exhibition. Columbus, Columbus, Ohio, October 20-25, 2019. Title: "Enabling hydrogen as an energy carrier through analytical electron microscopy;" D. A. Cullen (**invited lecture**).
8. 236th Meeting of the Electrochemical Society, Atlanta, Georgia, October 13-17, 2019. Title: "Electrochemical Characterization Methods of Fe-Based Oxygen Reduction Reaction Electrocatalysts for Polymer Electrolyte Fuel Cells;" J. Park, M. Ferrandon, D. J. Myers, H. T. Chung, S. Komini Babu, P. Zelenay.
9. 236th Meeting of the Electrochemical Society, Atlanta, Georgia, October 13-17, 2019. Title: "Nuclear Resonance Vibration Spectroscopy Study of 57-Fe-Enriched Atomically Dispersed (AD)Fe-N-C Oxygen Reduction Reaction Catalyst for Polymer Electrolyte Fuel Cells;" H. Chung, J. Park, N. Kariuki, J. Zhao, D. Cullen, K. More, D. Myers, E. Alp, P. Zelenay.
10. 236th Meeting of the Electrochemical Society, Atlanta, Georgia, October 13-17, 2019. Title: "Activity and Composition of Fe-Based Oxygen Reduction Reaction Electrocatalysts Synthesized and Characterized Using High-Throughput Approaches" D. J. Myers, M. Ferrandon, J. Park, H. Lv, V. R. Stamenkovic, A. J. Kropf, E. C. Wegener.
11. 236th Meeting of the Electrochemical Society, Atlanta, Georgia, October 13-17, 2019. Title: "Layered PGM-Free Electrode for Improved Mass Transport;" S. Komini Babu, X. Yin, U. Martinez, D. Cullen, G. Purdy, P. Zelenay.
12. 236th Meeting of the Electrochemical Society, Atlanta, Georgia, October 13-17, 2019. Title: "ElectroCat: Expediting PGM-Free Fuel Cell Catalyst and Electrode Development;" D. Papageorgopoulos, S. Thompson, D. Myers, K. More, K. C. Neyerlin, P. Zelenay (**invited lecture**).
13. UTSI MABE Departmental Series Seminar, Tullahoma, Tennessee, October 9, 2019. Title: "Accelerated Catalyst Development for the Emerging Hydrogen Economy;" D.A. Cullen (**invited lecture**).
14. Advanced Photon Source Upgrade (APS-U) Workshop, Catalysis Research at APS-U, Lemont, IL, October 4, 2019. Title: "X-ray Absorption, Scattering, Tomography, and Nuclear Resonance Vibrational Spectroscopy Studies of Platinum Group Metal-free Oxygen Reduction Reaction Catalysts and Electrodes." D. Myers (presenter), A.J. Kropf, J. Wright, C. F. Cetinbas, R. Ahluwalia, J. Park, N. Kariuki, A. Farghaly, E. Alp, J. Yang, H. Chung, P. Zelenay (**invited lecture**).

15. Advanced Manufacturing and Characterization of Fuel Cells and Electrolyzers Workshop, University of Connecticut, Storrs, Connecticut, September 23-24, 2019. Title: "Advanced Microscopy Methods to Interrogate Materials and Interfaces in Fuel Cell Catalyst Layers;" K. L. More (**invited lecture**).
16. Electrolysis and Fuel Cells Discussions (EFCD 2019), La Grande Motte, France, September 15-18, 2019. Title: "Platinum Group Metal-Free Catalysts for Oxygen Reduction: State of the Art, Mechanistic Insights, and Challenges;" P. Zelenay, H. T. Chung, E. F. Holby, U. Martinez, S. Komini Babu, V. Bhooshan Ramani, X. Yin (**invited keynote lecture**).
17. 257th ACS National Meeting & Exposition, San Diego, California, August 25-29, 2019. Title: "Understanding Electrode Design and Degradation in Fuel Cells;" D. A. Cullen, K. L. More (**invited lecture**).
18. University of Padua, Department of Industrial Engineering, Padua, Italy, August 2, 2019. Title: "Electrocatalysis at Noble Metal-free Materials. Part II: (a) Test protocols for platinum group metal-free ORR catalysts; (b) Molecular catalysts for hydrogen evolution and two-electron oxygen reduction;" P. Zelenay (**invited lecture**).
19. University of Padua, Department of Industrial Engineering, Padua, Italy, July 31, 2019. Title: "Electrocatalysis at Noble Metal-free Materials Part I: "Progress in Performance and Understanding of the Mechanism of Oxygen Reduction Reaction (ORR);" P. Zelenay (**invited lecture**).
20. European Fuel Cells Forum, Lucerne, Switzerland, July 2-5, 2019. Title: "Platinum Group Metal-free Electrocatalysts for Fuel Cell Applications;" X. Yin, H. T. Chung, S. Komini Babu, U. Martinez, G. M. Purdy, E. F. Holby, P. Zelenay (**invited lecture**).
21. First Telluride Science Research Center (TSRC) Workshop on PGM-free Electrocatalysis, Telluride, Colorado, June 24-29, 2019. Title: "PGM-free Catalyst Durability (or lack of thereof);" P. Zelenay (**invited lecture**).
22. First Telluride Science Research Center (TSRC) Workshop on PGM-free Electrocatalysis, Telluride, Colorado, June 24-29, 2019. Title: "*In Situ* and Operando Characterization of PGM-free Electrodes via Electrochemical Diagnostics;" K. C. Neyerlin (**invited lecture**).
23. First Telluride Science Research Center (TSRC) Workshop on PGM-free Electrocatalysis, Telluride, Colorado, June 24-29, 2019. Title: "Atomic-level insights into platinum group metal-free electrocatalysts derived from metal organic frameworks;" D. A. Cullen (**invited lecture**).
24. First Telluride Science Research Center (TSRC) Workshop on PGM-free Electrocatalysis, Telluride, Colorado, June 24-29, 2019. Title: "Evolution of Fe Species during Pyrolysis of (Fe)Zn-ZIF; In Situ Mössbauer and X-Ray Absorption Spectroscopy Studies of Atomically-Dispersed Fe-N-C Oxygen Reduction Reaction Catalysts;" D. J. Myers (**invited lecture**).
25. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Structure-Activity Data Mining for Hydrogen Evolution Reaction at Organic Molecular Electrocatalysts;" X. Yin, E. F. Holby, P. Zelenay.
26. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "High-Throughput Synthesis and Characterization of PGM-Free PEFC Cathode Catalysts", J. Park, M. Ferrandon, E. Coleman, N. N. Kariuki, V. R. Stamenkovic, D. J. Myers.

27. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Precious Metal-Free Electrocatalysis: Accomplishments and Challenges;" P. Zelenay (**invited lecture**).
28. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Microstructure Characterization of PGM-Free Catalyst Ink Using in-Situ Ultra Small Angle X-Ray Scattering", J. Park, N. N. Kariuki, D. J. Myers, H. Zhang, G. Wu.
29. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "*In Situ* Mössbauer and X-Ray Absorption Spectroscopy Studies of Atomically-Dispersed Fe-N-C Oxygen Reduction Reaction Catalysts;" D. J. Myers, E. E. Alp, H. T. Chung, P. Zelenay, D. E. Brown, W. Bi, H. Mistry, A. J. Kropf, J. Park, N. N. Kariuki, K. L. More, D. A. Cullen.
30. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Electrode Layer Development and in Situ Diagnostic Characterization in Low Temperature Fuel Cells;" K. C. Neyerlin, T. Van Cleve, G. Wang, A. G. Star, S. Kabir, L. Osmieri, S. Khandavalli, M. Wang, M. Ulsh, S. A. Mauger, S. Medina, S. Pylypenko.
31. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "PGM-Free Electrode Development and Optimization Using H₂ Limiting Current;" G. Wang, A. G. Star, L. Osmieri, K. C. Neyerlin.
32. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Use of a Segmented Cell for the Development of PGM-Free Cathode Catalyst Layers for Polymer Electrolyte Fuel Cells;" L. Osmieri, S. A. Mauger, E. Klein, M. Ulsh, K. C. Neyerlin, G. Bender.
33. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "On-Line Inductively-Coupled Plasma Mass Spectrometry Characterization of Transition Metal Dissolution in Electrochemical Environments;" D. J. Myers, N. N. Kariuki (**invited lecture**).
34. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Nuclear Resonance Vibrational Spectroscopy and Mössbauer Spectroscopy Studies of Atomically Dispersed (AD)⁵⁷Fe-N-C Oxygen Reduction Reaction Catalysts for Polymer Electrolyte Fuel Cells;" H. T. Chung, E. F. Holby, S. Komini Babu, J. Park, N. N. Kariuki, A. A. Farghaly, J. Zhao, W. Bi, D. A. Cullen, H. M. Meyer, III, E. E. Alp, K. L. More, D. J. Myers, P. Zelenay.
35. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Electron microscopy study of degradation mechanisms in platinum group metal-free catalysts;" D.A. Cullen, K. L. More, L. Osmieri, K.C. Neyerlin.
36. 235th Meeting of the Electrochemical Society, Dallas, Texas, May 26-30, 2019. Title: "Structure-Function Relationships of PGM-Free ORR Electrocatalysts from Density Functional Theory;" E. F. Holby, U. Martinez, S. Komini Babu, X. Yin, H. T. Chung, P. Zelenay.
37. Cornell Center for Materials Research (CCMR) Symposium on Electrochemical Energy Storage and Conversion, Ithaca, New York, May 22, 2019. Title: "Beyond Platinum Alloy Cathode Catalysts for Polymer Electrolyte Fuel Cells." D. Myers. (**invited lecture**)
38. 2019 MRS Spring Meeting & Exhibit, Phoenix, Arizona, April 22-26, 2019. Title: "Searching for the Active Site in Carbon-Based Noble Metal-Free Oxygen Reduction Electrocatalysts;" P. Zelenay, S. Komini Babu, H. T. Chung, U. Martinez, X. Yin, G. M. Purdy, E. F. Holby (**invited lecture**).

39. 2019 MRS Spring Meeting & Exhibit, Phoenix, Arizona, April 22-26, 2019. Title: "High-Throughput Synthesis and Characterization of PGM-Free Oxygen Reduction Electrocatalysts for Polymer Electrolyte Fuel Cells", D. Myers, M. Ferrandon, J. Park, H. Lv, N. Kariuki, C. Yang, A. J. Kropf, and E. Wegener. **(invited lecture)**.
40. 2019 MRS Spring Meeting & Exhibit, Phoenix, Arizona, April 22-26, 2019. Title: "Atomic-Level Insights into Platinum Group Metal-Free Electrocatalysts Derived from Metal Organic Frameworks;" D. Cullen, K. More, G. Wu, D. Myers, K.C. Neyerlin, H. T. Chung, P. Zelenay.
41. 3rd International Fuel Cells Workshop, Tel Aviv – Ramat Gan, Israel, October 29-November 1, 2018. Title: "Oxygen Reduction at PGM-free Electrocatalysts: Coming of Age?" P. Zelenay **(invited lecture)**.
42. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "Identification of Possible Degradation Mechanisms of PGM-Free Electrocatalysts during Fuel Cell Operation;" U. Martinez, S. Komini Babu, E. F. Holby, X. Yin, B. T. Manard, and P. Zelenay.
43. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "Activity and Durability Insights for Atomically Dispersed (AD)Fe-N-C Oxygen Reduction Catalysts;" H. T. Chung, D. A. Cullen, X. Yin, S. Komini Babu, K. L. More, D. J. Myers, and P. Zelenay.
44. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "X-Ray Absorption Spectroscopy, Scattering, and Tomography Characterization of Platinum Group Metal-Free Oxygen Reduction Reaction Catalysts and Electrodes;" D. J. Myers, A. J. Kropf, D. Yang, C. Yang, H. Mistry, F. Cetinbas, R. Ahluwalia, J. Park, N. Kariuki, S. Komini Babu, H. T. Chung, and P. Zelenay.
45. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "High-Throughput Performance Testing in 25-Electrode Array Fuel Cell for Platinum Group Metal-Free Catalysts;" J. Park, N. Kariuki, D. J. Myers, H. T. Chung, U. Martinez, and P. Zelenay.
46. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "Formation of Metal-Nitrogen Sites in Atomically-Dispersed Catalysts Observed By *in Situ* Microscopy;" D. A. Cullen, K. L. More, D. J. Myers, G. Wu, S. Litster, H. Xu, H. T. Chung, and P. Zelenay.
47. AiMES 2018 and 234th Meeting of The Electrochemical Society, Cancun, Mexico, September 30-October 4, 2018. Title: "Molecular Probes for the Identification and Quantification of Active Sites in PGM-free ORR Catalysts;" S. Komini Babu, U. Martinez, E. F. Holby, N. Kariuki, K. P. Ramaiyan, K. Artyushkova, G. M. Purdy, H. T. Chung, D. J. Myers, and P. Zelenay.
48. International Symposium on Electrocatalysis, Szczyrk, Poland, August 29-September 1, 2018. Title: "Recent Advances in PGM-free Electrocatalysis of Oxygen Reduction;" P. Zelenay, U. Martinez, S. Komini Babu, H. T. Chung, X. Yin, and E. F. Holby **(invited plenary lecture)**.
49. International Conference on Electrochemical Energy Science and Technology, Niagara Falls, Ontario, Canada, August 16, 2018. Title: "Performance and Durability of Low Platinum and Platinum Group Metal-free Polymer Electrolyte Fuel Cells;" D. J. Myers **(invited plenary lecture)**.

50. 256th ACS National Meeting, Boston, MA, August 19-23, 2018. Title: "Direct Observation of Atomically Dispersed Catalysts for Oxygen Reduction;" D.A. Cullen and K.L. More (**invited lecture**).
51. International Symposium on Electrocatalysis, Szczyrk, Poland, August 29-September 1, 2018. Title: "Recent Advances in PGM-free Electrocatalysis of Oxygen Reduction;" P. Zelenay, U. Martinez, S. Komini Babu, H. T. Chung, X. Yin, and E. F. Holby (**invited plenary lecture**).
52. 2018 Gordon Research Conference – Fuel Cells, Smithfield, Rhode Island, July 29 – August 3, 2018. Title: "X-Ray Scattering, Spectroscopy and Tomography Characterization of PEFC Cathode Catalysts, Inks, and Electrodes;" D. J. Myers (**invited lecture**).
53. 2018 Gordon Research Conference – Fuel Cells, Smithfield, Rhode Island, July 29 – August 3, 2018. Title: "ORR Active Site Probing on PGM-free Catalysts;" S. Komini Babu, U. Martinez, E. F. Holby, D. Myers, H. T. Chung, and P. Zelenay (poster presentation; best poster award).
54. 233rd Meeting of the Electrochemical Society, Seattle, Washington, May 13-17, 2018. Title: "In Situ X-ray Absorption Spectroscopy Characterization of Iron-Carbon-Nitrogen Oxygen Reduction Reaction Catalysts during Pyrolysis;" D. J. Myers, A. J. Kropf, and D. Yang (**invited lecture**).
55. 233rd Meeting of the Electrochemical Society, Seattle, Washington, May 13-17, 2018. Title: "Operando Determination of Oxygen Reduction Reaction Kinetics on PGM-Free Electrocatalysts in a PEFC;" L. Osmieri, X. Wang, F. Cetinbas, H. T. Chung, X. Yin, S. Kabir, D. J. Myers, P. Zelenay, R. Ahluwalia, and K. C. Neyerlin.
56. 233rd Meeting of the Electrochemical Society, Seattle, Washington, May 13-17, 2018. Title: "Kinetic Insight into the Degradation Mechanism of PGM-Free ORR Catalysts;" X. Yin, U. Martinez, S. Komini Babu, H. T. Chung, G. M. Purdy, and P. Zelenay (**invited lecture**).
57. 233rd Meeting of the Electrochemical Society, Seattle, Washington, May 13-17, 2018. Title: "The Progress and Challenges in Oxygen Reduction Electrocatalysis without Precious Metals;" P. Zelenay (**invited keynote lecture**).
58. 233rd Meeting of the Electrochemical Society, Seattle, Washington, May 13-17, 2018. Title: "High-Throughput Activity and Performance Screening Methods for PGM-Free Catalysts;" J. Park, N. Kariuki, D. J. Myers, B.T. Hohman, S. Lee, H. T. Chung, U. Martinez, and P. Zelenay.
59. 2018 Materials Research Society Spring Meeting and Exhibit, Phoenix, Arizona, April 2-6, 2018. Title: "Atomic-level Transformations in Platinum Group Metal-free Electrocatalysts Observed during *In situ* Annealing;" D. Cullen, B. Sneed, K. More, H. Chung, E. Holby, P. Zelenay, J. Spendelow, and G. Wu.
60. American Chemical Society National Meeting and Exposition, March 18-22, 2018. Title: "Electrocatalysis without Precious Metals;" P. Zelenay (**invited lecture**).
61. Colorado School of Mines, Golden, Colorado, December 8, 2017. Title: "Oxygen Reduction at Platinum Group Metal-free Electrocatalysts: Progress in Performance and Understanding of Reaction Mechanism;" P. Zelenay (**invited lecture**).
62. 2nd International Fuel Cells Workshop, Ramat Gan, Israel, October 30-31, 2017. Title: "Recent Developments in PGM-free Electrocatalysis of Oxygen Reduction;" P. Zelenay (**invited lecture**).

63. 2nd International Fuel Cells Workshop, Ramat Gan, Israel, October 30-31, 2017. Title: "Activity, Performance, and Durability of Polymer Electrolyte Fuel Cell Catalysts and Electrodes;" D. Myers (**invited lecture**).
64. University of California Santa Cruz, Chemistry and Biochemistry, Santa Cruz, California, October 23, 2017. Title: "PGM-free Electrocatalysts for Oxygen Reduction Reaction in Fuel Cells: State of the Art and Challenges;" P. Zelenay (**invited lecture**).
65. University of California Merced, School of Natural Sciences, Chemistry and Chemical Biology, Merced, California, October 20, 2017. Title: "Electrocatalysis of Oxygen Reduction at Platinum Group Metal-free Catalysts;" P. Zelenay (**invited lecture**).
66. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Electron Microscopy Observations of Catalyst-Support Interactions in Polymer Electrolyte Membrane Fuel Cells;" D. A. Cullen, B.T. Sneed, G. Wu, J. Spendelow, H. T. Chung, P. Zelenay, and K. L. More.
67. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Organic Molecular Catalyst for Electrochemical Production of Hydrogen Peroxide;" X. Yin, L. Lin, U. Martinez, H. T. Chung, and P. Zelenay.
68. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "High-Throughput Synthesis and Characterization of PGM-Free Oxygen Reduction Reaction Electrocatalysts;" D.J. Myers, M. Ferrandon, A.J. Kropf, D. Yang, N.N. Kariuki, J. Park, and S. Lee.
69. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Microstructural Modeling of PEFC Catalyst Layer Performance and Durability;" S. Ogawa, S. Komini Babu, E. Padgett, H. T. Chung, P. Zelenay, A. Kongkanand, and S. Litster.
70. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Modeling Durability of PGM-free Active Site Structures at the Atomic Scale;" E. F. Holby, U. Martinez, H. T. Chung, and P. Zelenay.
71. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Atomically Dispersed (AD)Fe-N-C Oxygen Reduction Catalysts for Polymer Electrolyte Membrane Fuel Cells;" H. Chung, D. A. Cullen, B. T. Sneed, H. M. Meyer III, L. Lin, X. Yin, K. L. More, and P. Zelenay.
72. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Structure-Activity-Durability Relationships of (CM+PANI)-Me-C PGM-free Catalysts;" U. Martinez, S. Komini Babu, H. T. Chung, L. Lin, G. M. Purdy, and P. Zelenay.
73. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "Influence of Transition Metal and Synthesis Methodology on the Active Site Density on the Surface of PGM-Free Catalysts;" S. Komini Babu, U. Martinez, H. Chung, L. Lin, X. Yin, and P. Zelenay.
74. 232nd Meeting of the Electrochemical Society, National Harbor, Maryland, October 1-5, 2017. Title: "PGM-Free Electrode Microstructure Analysis and Transport Modeling;" F. Cetinbas, N. Kariuki, R. Ahluwalia, H. T. Chung, P. Zelenay, and D. J. Myers

75. ElectroCat Modeling Workshop, Washington, D.C., USA. September 20, 2017. Title: "ElectroCat Overview;" P. Zelenay (**invited lecture**).
76. ElectroCat Modeling Workshop, Washington, D.C., USA. September 20, 2017. Title: "High-throughput Experimental Activities in ElectroCat;" D. Myers, J. Park, N. Kariuki, M. Ferrandon, A. J. Kropf, D. Yang, H. Lv, A. Zakutayev, G. Bender, and H. Dinh. (**invited lecture**)
77. Microscopy & Microanalysis 2017, St. Louis, Missouri, August 6-10, 2017. Title: "Overcoming the Challenges of Beam-sensitivity in Fuel Cell Electrodes;" D.A. Cullen, B.T. Sneed, and K. L. More.
78. Milan Polytechnic, Milan, Italy, June 27, 2017. Title: "Platinum Group Metal-free Electrocatalysts for Oxygen Reduction in Fuel Cells;" P. Zelenay (**invited lecture**).
79. 21st International Conference on Solid State Ionics (SSI-21), Padua, Italy, June 18-23, 2017. Title: "PEFC Cathode Catalyst Layer Electrode Microstructure Analysis and Transport Modeling," C. F. Cetinbas, X. Wang, R. K. Ahluwalia, N. N. Kariuki, R. Winarski, V. J. De Andrade, and D. J. Myers (**invited lecture**).
80. 231st Meeting of the Electrochemical Society, New Orleans, Louisiana, May 28-June 1, 2017. Title: "The Electrocat (Electrocatalysis) Consortium;" A. R. Wilson, D. C. Papageorgopoulos, D. J. Myers, P. Zelenay, H. N. Dinh, and K. L. More (**invited lecture**).
81. 231st Meeting of the Electrochemical Society, New Orleans, Louisiana, May 28-June 1, 2017. Title: "Porous Electrode Engineering for Platinum Group Metal-Free Oxygen Reduction Reaction Catalysts;" S. Komini Babu, S. Ogawa, H. T. Chung, P. Zelenay, and S. Litster (**invited lecture**).
82. 231st Meeting of the Electrochemical Society, New Orleans, Louisiana, May 28-June 1, 2017. Title: "High-Performance PGM-Free Electrocatalysts for the Polymer Electrolyte Fuel Cell Cathode;" X. Yin, H. T. Chung, L. Lin, G. M. Purdy, U. Martinez, and P. Zelenay (**invited lecture**).
83. 231st Meeting of the Electrochemical Society, New Orleans, Louisiana, May 28-June 1, 2017. Title: "Effects of Porosity and Ionomer Composition on Fuel Cell Performance of PGM-Free ORR Catalysts;" X. Yin, L. Lin, H. T. Chung, S. Komini Babu, U. Martinez, G. M. Purdy, and P. Zelenay.
84. 231st Meeting of the Electrochemical Society, New Orleans, Louisiana, May 28-June 1, 2017. Title: "Metal-Organic Framework-Derived Atomic Iron-Dispersed Carbon Electrocatalysts for Oxygen Reduction in Acidic Polymer Electrolyte Fuel Cells;" H. Zhang, H. T. Chung, D. A. Cullen, K. L. More, P. Zelenay, and G. Wu.
85. Israel Research Center for Electrochemical Propulsion (INREP) Energy Conference, Bar-Ilan University, Ramat Gan, Israel, May 9-10, 2017. Title: "PGM-free ORR Electrocatalysis: Progress and Challenges on the Path to Viability;" P. Zelenay (**invited lecture**).
86. DOE Catalysis-Durability Working Group Meeting, Argonne National Laboratory, Lemont, Illinois, May 2-3, 2017. Title: "Introduction to PGM-free Catalysis and Protocols;" P. Zelenay.
87. Department of Chemical and Biomolecular Engineering, University of Tennessee, Knoxville, Tennessee, March 27, 2017. Title: "Platinum Group Metal-free Electrocatalysts for Oxygen Reduction in Fuel Cells;" P. Zelenay (**invited lecture**).

88. Technische Universität Darmstadt, Graduate School of Energy Science and Engineering, Darmstadt, Germany, February 7, 2017. Title: "PGM-free Electrocatalysis Research at Los Alamos;" P. Zelenay (**invited lecture**).
89. 7th International Conference on Fundamentals and Development of Fuel Cells (FDfC 2017), Stuttgart, Germany, January 31- February 2, 2017. Title: "Oxygen Reduction on PGM-free Electrocatalysts;" P. Zelenay, H. T. Chung, U. Martinez, L. Lin, X. Yin, G. M. Purdy, and E. F. Holby (**invited lecture**).
90. Beijing Forum 2016 on Electrochemical Frontier, Wuhan, China, December 6-8, 2016. Title: "Recent Progress in ORR Electrocatalysis on Me-N-C Catalysts;" U. Martinez, J. Dumont, L. Lin, X. Yin, G. M. Purdy, E. F. Holby, H. T. Chung, and P. Zelenay (**invited lecture**).
91. School of Materials Science and Engineering, Huazhong University of Science and Technology, Wuhan, China, December 6, 2016. Title: "Oxygen Reduction Reaction at Platinum Group Metal-free Fuel Cell Electrocatalysts;" P. Zelenay (**invited lecture**).
92. DGIST Global Innovation Festival (DGIF), Daegu, South Korea, December 1-2, 2016. Title: "Fuel Cell Electrocatalysis: Accomplishments and Challenges;" P. Zelenay (**invited lecture**).
93. Department of Energy Systems Engineering, Daegu Gyeongbuk Institute of Science Technology (DGIST), Daegu, South Korea, November 30, 2016. Title: "A Few Highlights from PGM-free ORR Catalysis Research at Los Alamos National Laboratory;" P. Zelenay (**invited lecture**).
94. Materials Research Society, Boston, MA, Nov. 29-Dec. 4, 2016. Title: "Analytical Characterization of non-PGM Catalysts for PEM Fuel Cells", D.A. Cullen, B.T. Sneed, H.M. Meyer III, K.L. More, H. Chung, and P. Zelenay.
95. Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Gothenburg, Sweden, November 24, 2016. Title: "Platinum Group Metal-free ORR Catalysts for Fuel Cells Applications;" P. Zelenay (**invited lecture**).
96. Fuel Cells Workshop, Bar-Ilan University, Ramat Gan, Israel, November 1, 2016. Title: "PGM-free ORR Catalysts for Fuel Cell Applications;" P. Zelenay (**invited lecture**).
97. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Graphene Oxide-Based Non-Precious Metal Catalysts for Oxygen Reduction Reaction with Improved Selectivity and Performance;" J. H. Dumont, U. Martinez, G. M. Purdy, A. M. Dattelbaum, P. Zelenay, P. Atanassov, A. Mohite, and G. Gupta.
98. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Binary Fe-Free Transition Metal Catalysts for the Oxygen Reduction Reaction;" U. Martinez, E. F. Holby, J. H. Dumont, and P. Zelenay.
99. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Zinc-Derived Microporous Structure in Non-Precious Metal Catalysts for Polymer Electrolyte Fuel Cell Cathodes;" L. Lin, H. T. Chung, X. Yin, U. Martinez, and P. Zelenay.
100. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "High-Temperature Synthesized PGM-Free Oxygen Reduction Reaction Catalyst;" H. T. Chung, D. A. Cullen, B. Sneed, L. Lin, X. Yin, U. Martinez, G. M. Purdy, K. L. More, and P. Zelenay.

101. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Resolving Active Sites and Porosity in PGM-Free Catalysts by Electron Microscopy;" D. A. Cullen, B. Sneed, K. L. More, J. H. Brewster, M. Odgaard, H. T. Chung, and P. Zelenay.
102. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Modeling PGM-Free Active Site Structures: Activity and Durability;" E. F. Holby, U. Martinez, H. T. Chung, and P. Zelenay.
103. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Magnetic Purification of PGM-Free Catalysts;" X. Yin, U. Martinez, H. T. Chung, L. Lin, and P. Zelenay (poster presentation).
104. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Imaging Fuel Cell Components: From Flow Field Channels to Catalyst Layers;" D. Spornjak, R. L. Borup, D. S. Hussey, P. Zelenay, and R. Mukundan (**invited lecture**).
105. Pacific Rim Meeting on Electrochemical and Solid-State Science (PRiME), Honolulu, Hawaii, October 2-7, 2016. Title: "Direct Simulations of Coupled Transport and Reaction on Nano-Scale X-Ray Computed Tomography Images of Platinum Group Metal-Free Catalyst Cathodes;" S. Ogawa, S. Komini Babu, H. T. Chung, P. Zelenay, and S. Litster.
106. Workshop on Material Challenges for Fuel Cell & Hydrogen Technologies, Grenoble, France, September 19-21, 2016. Title: "PGM-free ORR Catalysts: State of the Art and Recent Progress;" P. Zelenay, H. T. Chung, U. Martinez, L. Lin, Xi Yin, G. M. Purdy, and E. F. Holby (**invited plenary lecture**).
107. 67th Annual Meeting of the International Society of Electrochemistry, The Hague, Netherlands, August 21-26, 2016. Title: "Recent Progress in the Development of Non-Precious Metal ORR Catalysts for Fuel Cells;" P. Zelenay, H. T. Chung, U. Martinez, L. Lin, X. Yin, G. M. Purdy, and E. F. Holby (**invited lecture**).
108. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2017, Title: "Overview of high-throughput techniques as applied to fuel cell catalysts and electrodes", D. Myers.
109. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2017, Title: "Summary of ElectroCat experimental capabilities", P. Zelenay, D. Myers, K. More, and H. Dinh.
110. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2016, Title: "DFT modeling of PGM-free catalyst activity and durability", T. Holby.
111. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2016, Title: "Electrode microstructure and transport modeling", F. Cetinbas
112. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2016, Title: "Data management and technology transfer/agreement approaches", I. Foster and L. Barber.
113. ElectroCat Workshop, Argonne National Laboratory, Lemont, Illinois, July 26, 2016. Title: "State of the art of PGM-free catalyst activity and durability;" P. Zelenay.

114. Microscopy & Microanalysis, Columbus, OH, July 24-28, 2016. Title: "Fuel Cell Electrode Optimization through Multi-scale Analytical Microscopy", D.A. Cullen, B.T. Sneed, and K.L. More.
115. TechConnect World 2016, Washington, D.C., May 22-24, 2016. Title: "Advancing Fuel Cell Materials through Electron Microscopy", D.A. Cullen (**invited lecture**).

Webinars and Expert Panels

1. D. Myers and P. Zelenay, "ElectroCat (Electrocatalysis Consortium: Advancing PGM-Free Electrocatalysts for Next-Generation Fuel Cells;" U.S. Department of Energy Fuel Cell Technologies Office (FCTO), September 26, 2018 (**invited**).
2. D. Myers and P. Zelenay, "ElectroCat (Electrocatalysis Consortium;" DOE-EERE H2 & FC Working Group meeting, June 22, 2018 (**invited**).
3. A. Wilson, D. Myers, P. Zelenay, "ElectroCat Lab Consortium Overview;" DOE Office of Energy Efficiency and Renewable Energy, Fuel Cell Technologies Office, April 30, 2018 (**invited**).
4. D. Myers, M. Allendorf, and P. Zelenay, "FCTO Lab Consortia Overview: ElectroCat and HyMARC;" DOE Energy Efficiency and Renewable Energy Office, Fuel Cell Technologies Office, November 8, 2016 (**invited**).
http://energy.gov/sites/prod/files/2016/11/f34/fcto_webinarslides_electrocat_hymarc_consortia_overview_110816.pdf
5. P. Zelenay, D. Stolten, L. Elbaz (S. Satyapal – moderator), "Panel 2: A Global Fuel Cell Technology Roadmap;" Fuel Choices Summit, Tel Aviv, Israel, November 2-3, 2016 (**invited**).
6. D. Papageorgopoulos, E. Miller, D. Myers, and P. Zelenay, "FCTO ElectroCat (Electrocatalysis) Consortium: National Laboratory Engagement;" DOE Energy Efficiency and Renewable Energy Office, Fuel Cell Technologies Office, February 4, 2016 (**invited**).

Invention Disclosures, Patent Applications, and Patents Issued

1. H. Zhang, H. T. Chung, P. Zelenay. "Highly durable and active platinum group metal-free catalysts developed via chemical vapor deposition approach for proton exchange membrane fuel cells;" LANL invention disclosure S133864, February 2020.
2. B.-Z. Zhan, Z. He, H. T. Chung, P. Zelenay; "Metal nanoparticle-deposited, nitrogen-doped carbon adsorbent produced by e.g. contacting nitrogen precursor and metal-containing salt in first strong acid solution and heating used to remove sulfur compounds from hydrocarbon feed stream;" U.S. Patent US2019262798-A1 issued on August 29, 2019.
3. X. Yin, P. Zelenay, "2,2'-dipyridylamine as a Catalyst for An Electrochemical Cell;" U.S. Patent Application No. 62/860,964 filed on June 13, 2019 (Triad Ref. No. S133691.000).
4. M. Ferrandon, J. Park, D. J. Myers, "Metal Dopants in iron-based Electrocatalysts for Platinum Metal Group (PGM)-free PEMFCs;" ANL invention disclosure, ANL-IN-19-124, 2019.
5. H.T. Chung, P. Zelenay; "ZIF-L derived atomically dispersed (AD)Fe-N-C catalysts for polymer electrolyte fuel cells;" LANL invention disclosure 2729, April 17, 2019.

6. J. Park, D.J. Myers, "Electrode Ink Deposition System for High-Throughput Polymer Electrolyte Fuel Cell;" ANL invention disclosure, ANL-IN-18-102, 2018.
7. H. T. Chung, L. Lin, and P. Zelenay; "Zinc-derived Microporous Structure in Non-Precious Catalysts for Polymer Electrolyte Fuel Cell Cathodes;" patent application filed on November 14, 2016.
8. G. Wu and P. Zelenay; "Non-precious Fuel Cell Catalysts Comprising Polyaniline" (divisional of U.S. Application No. 13/267,579); patent application filed October 17, 2016.