David A. Cullen

Alvin M. Weinberg Fellow
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EDUCATION

2010 Ph.D., Materials Science and Engineering, Arizona State University
Characterization of GaN-based high electron mobility transistor devices

2005 B.S., Applied Physics, Brigham Young University
Fingerprinting the α and γ phases of alumina using electron energy-loss spectroscopy

POSITIONS

2015-present **Joint Faculty Member,** The Bredesen Center**,** University of Tennessee, Knoxville, TN

2012-present **Research Staff Member, Microscopy Group**, Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN

2010-2012 **Alvin M. Weinberg Fellow**, Oak Ridge National Laboratory, Oak Ridge, TN

2005-2010 **Graduate Research Associate,** School of Materials, Arizona State University, Tempe, AZ

2007-summer **Graduate Research Intern,** Shell Global Solutions, Houston, TX

2005-summer **Graduate Fellow,** Electron Microscopy Laboratory, Idaho National Laboratory, Idaho Falls, ID

PUBLICATIONS (h-index=13)

1. R. Lv, G. Chen, Q. Li, A. McCreary, A. Botello-Méndez, S.V. Morozov, L. Liang, X. Declerck, N. Perea-López, D.A. Cullen, S, Feng, A.L. Elías, R. Cruz-Silva, K. Fujisawa, M. Endo, F. Kanga, J.-C. Charlier, V. Meunier, M. Pank, A.R. Harutyunyan, K,S. Novoselov, and M. Terrones, "Ultrasensitive gas detection of large-area boron-doped graphene," *Proceedings of the National Academy of Sciences* (accepted).

2. A. Bulusu, A. Singh, C.Y. Wang, A. Dindar, C. F. Hernandez, H. Kim, D. A. Cullen, B. Kippelen, Samuel Graham. Engineering the Mechanical Properties of Ultrabarrier Films Grown by Atomic Layer Deposition for the Encapsulation of Printed Electronics. *Journal of Applied Physics* (accepted).

3. Z. Xie, A.C. Terracciano, D.A. Cullen, R.G. Blair, and N. Orlovskaya, "High Temperature Ir Segregation in Ir-B Ceramics: Effect of Oxygen Presence on Stability of IrB2 and Other Ir-B Phases," *Advances in Applied Ceramics* (accepted).

4. A. J. Steinbach, D. van der Vliet, A. E. Hester, J. Erlebacher, C. Duru, I. Davy, M. Kuznia, and D. A. Cullen. Recent Progress in NSTF ORR Electrocatalyst Development for PEM Fuel Cells. *ECS Transactions*, (accepted).

5. L.Guétaz, M. Lopez-Haro, S. Escribano, A. Morin, G. Gebel, D. Cullen, K. More and R. Borup. Catalyst-Layer Ionomer Imaging of Fuel Cells. *ECS Transactions*, (accepted).

6. J. Mo, S.M. Steen, S. Retterer, D.A. Cullen, A. Terekhov, and F.-Y. Zheng. "Mask-Patterned Wet Etching of Thin Titanium Liquid/Gas Diffusion Layers for a PEMEC," *ECS Transactions*, 66 (2015) 3-10.

7. P. Datskos, D.A. Cullen, and J. Sharma, "Step-by-Step Growth of Complex Oxide Microstructures," *Angewandte Chemie International Edition* **54** (2015) 9011-9015.

8. C. Kumara, X. Zuo, J. Ilavsky, D. Cullen, and A. Dass, "Atomic Structure of Au329 (SR) 84 Faradaurate Plasmonic Nanomolecules," *Journal of Physical Chemistry C* **6** (2015) 3320-3326.

9. Z. Xie, M. Lugovy, N. Orlovskaya, T. Graule, J. Kuebler, M. Mueller, H. Gao, M. Radovic, and D.A. Cullen, "Hexagonal OsB2: Sintering, microstructure and mechanical properties," *Journal of Alloys and Compounds* **634**, 168-178 (2015).

10. J. Zheng, D.A. Cullen, R.V. Forest, J.A. Wittkopf, Z. Zhuang, W. Sheng, J.G. Chen, and Y. Yan, "Platinum–Ruthenium Nanotubes and Platinum–Ruthenium Coated Copper Nanowires As Efficient Catalysts for Electro-Oxidation of Methanol," *ACS Catalysis* **634**, 1468-1474 (2015).

11. D.A. Cullen, M. Lopez-Haro, P. Bayle-Guillemaud, L. Guetaz, M.K. Debe, and A.J. Steinbach, "Linking morphology with activity through the lifetime of pretreated PtNi nanostructured thin film catalysts," *Journal of Materials Chemistry A* **3**, 11660-11667 (2015).

12. D.A. Cullen, R. Koestner, R.S. Kukreja, Z.Y. Liu, S. Minko, O. Trotsenko, A. Tokarev, L. Guetaz, H.M. Meyer III, C.M. Parish, and K.L. More, "Imaging and Microanalysis of Thin Ionomer Layers by Scanning Transmission Electron Microscopy," *Journal of the Electrochemical Society* 161 (2014) 6431-6439.

13. D.A. Cullen, K.L. More, L.L. Atanasoska, and R.T. Atanasoski, "Impact of IrRu Oxygen Evolution Reaction Catalysts on Pt Nanostructured Thin Films under Start-Up/Shutdown Cycling," *Journal of Power Sources* **269**, 671-681 (2014).

14. Z. Xie, R.G. Blair, N. Orlovskaya, D.A. Cullen, and E.A. Payzant, "Thermal stability of hexagonal OsB2," *Journal of Solid State Chemistry* **219** 210-219 (2014).

15. Q. Li, G. Wu, D.A. Cullen, K.L. More, N.H. Mack, H.T. Chung, and P. Zelenay, "Phosphate-Tolerant Oxygen Reduction Catalysts," *ACS Catalysis* **4**, 3193-3200 (2014).

16. R.J. Koestner, D.A. Cullen, R. Kukreja, S. Minko, H.M. Meyer, Z. Liu, and K.L. More, "High-Resolution Mapping of the PFSA Polymer Distribution in PEFC Electrode Layers," *ECS Transactions* **64**, 819-827 (2014).

17. C. Kumara, X.B. Zuo, D.A. Cullen, and A. Dass, "Faradaurate-940: Synthesis, Mass Spectrometry, Electron Microscopy, High-Energy X‐ray Diffraction, and X‐ray Scattering Study of Au(SR) Nanocrystals," *ACS Nano* **8** 6431-6439 (2014).

18. S.M. Alia, S. Pylypenko, K.C. Neyerlin, D.A. Cullen, S.S. Kocha, and B.S. Pivovar, "Platinum-Coated Cobalt Nanowires as Oxygen Reduction Reaction Electrocatalysts," *ACS Catalysis* **4** 2680-2686 (2014).

19. S.M. Alia, B.A. Larsen, S. Pylypenko, D.A. Cullen, D.R. Diercks, K.C. Neyerlin, S.S. Kocha, and B. S. Pivovar, "Platinum-Coated Nickel Nanowires as Oxygen-Reducing Electrocatalysts," *ACS Catalysis* **4** 1114-1119 (2014).

20. Z. Xie, M. Graule, N. Orlovskaya, E.A. Payzant, and D.A. Cullen, "Novel High Pressure Hexagonal OsB_2 by Mechanochemistry," *Journal of Solid State Chemistry* **215** 16-21 (2014).

21. C. Kumara, X.B. Zuo, J. Ilavsky, K.W. Chapman, D.A. Cullen, and A. Dass, "Super-Stable, Highly Monodisperse Plasmonic Faradaurate-500 Nanocrystals with 500 Gold Atoms," *Journal of The American Chemical Society* **136**[20] 7410-7417 (2014).

22. W. Gao, G. Wu, M.T. Janicke, D.A. Cullen, R. Mukundan, J.K. Baldwin, E.L. Brosha, C. Galande, P.M. Ajayan, K.L. More, A.M. Dattlebaum, and P. Zelenay, "Ozonated Graphene Oxide Film as a Proton-Exchange Membrane," *Angewandte Chemie - International Edition* **53**[14] 3588-3593 (2014).

23. L.L. Atanasoska, D.A. Cullen, A.E. Hester, and R.T. Atanasoski, "XPS and STEM Study of the Interface Formation between Ultra-Thin Ru and Ir OER Catalyst Layers and Perylene-Red Support Whiskers," ECS Transactions **50** 19-33 (2013).

24. B.P. Pearman, N. Mohajeri, D. Slattery, M. Hampton, S. Seal, and D. A. Cullen, "The Chemical Behavior and Degradation Mitigation Effect of Cerium Oxide Nanoparticles in Perfluorosulfonic Acid Polymer Electrolyte Membranes," *Polymer Degradation and Stability* **98**[9] 1766-1772 (2013).

25. A.C. Johnston-Peck, D. A. Cullen, and J. B. Tracy. Composition-Mediated Order-Disorder Transformation in FePt Nanoparticles," *Particle & Particle Systems Characterization* **30**[8] 678-682 (2013).

26. B.P. Pearman, N. Mohajeri, R.P. Brooker, M. Rodgers, D. Slattery, M. Hampton, D.A. Cullen, and S. Seal, "The Degradation Mitigation Effect of Cerium Oxide in Polymer Electrolyte Membranes in Extended Fuel Cell Durability Tests," *Journal of Power Sources* **225** 75-83 (2013).

27. D.A. Cullen, D.J. Smith, A. Passaseo, V. Tasco, A. Stocco, M. Meneghini, G. Meneghesso, and E. Zanoni, "Electroluminescence and Transmission Electron Microscopy Characterization of Reverse-Biased AlGaN/GaN Devices," *IEEE Transactions on Device and Materials Reliability* **13**[1] 126-134 (2013).

28. M. Li, D.A. Cullen, K. Sasaki, N.S. Mannkovic, K.L. More, and R.R Adzic, "Ternary Electrocatalysts for Oxidizing Ethanol to Carbon Dioxide: Making Ir Capable of Splitting C-C Bond," *Journal of The American Chemical Society* **135**[1] 132-141 (2013).

29. R. T. Atanasoski, D.A. Cullen, G. Vernstrom, G. Haugen, and L.L. Atanasoska, "A Materials-Based Mitigation Strategy for SU/SD in PEM Fuel Cells: Properties and Performance-Specific Testing of IrRu OER Catalysts," *ECS Electrochemistry Letters* **2**[3] F25-F28 (2013).

30. R.T. Atanasoski, L.L. Atanasoska, and D.A. Cullen, "Efficient Oxygen Evolution Reaction Catalysts for Cell Reversal and Start/Stop Tolerance" *Journal of the Serbian Chemical Society* **78**[12] 1993-2005 (2013).

31. M.P. Rodgers, N.P. Pearman, L.J. Bonville, D.A. Cullen, N. Mohajeri, and D.K. Slattery, "Evaluation of the Effect of Impregnated Platinum on PFSA Degradation for PEM Fuel Cells," *Journal of the Electrochemical Society* **160**[10] F1123-F1128 (2013).

32. R.T. Atanasoski, L.L. Atanasoska, D.A. Cullen, G.M. Haugen, K.L. More, and G.D. Vernstrom, "Fuel Cells Catalyst for Start-Up and Shutdown Conditions: Electrochemical, XPS, and STEM Evaluation of Sputter-Deposited Ru, Ir, and Ti on Pt-Coated Nanostructured Thin Film Supports," *Electrocatalysis* **3**[3-4] 284-297 (2012).

33. Y. Zhu, D.A. Cullen, S. Kar, M.P. Free, and L.F. Allard, "Evaluation of Al_3Mg_2 Precipitates and Mn-rich phase in Aluminum-Magnesium Alloy Based on Scanning Transmission Electron Microscopy Imaging," *Metallurgical and Materials Transactions A* **43A**[13] 4933-4939 (2012).

34. M. Johnson, D.A. Cullen, L. Liu, T.S. Kang, F. Ren, C.Y. Chang, S.J. Pearton, S. Jang, W.J. Johnson, and D.J. Smith, "Transmission Electron Microscopy Characterization of Electrically Stressed AlGaN/GaN High Electron Mobility Transistor Devices," *Journal of Vacuum Science & Technology B* **30**[6] Article 062204 (2012).

35. Y. Chen, N. Orlovskaya, M. Klimov, X. Huang, D.A. Cullen, T. Graule, and J. Kuebler, "Layered YSZ/SCSZ/YSZ Electrolytes for Intermediate Temperature SOFC Part I: Design and Manufacturing," *Fuel Cells* **12** 722-731 (2012).

36. D.P Hashim, N.T. Narayanan, J.M. Romo-Herrera, D.A. Cullen, M.G. Hahm, P. Lezzi, J.A. Suttle, D. Kelkhoff, E. Munoz-Santoval, S. Ganguli, A.K. Roy, D.J. Smith, R. Vajtai, B.G. Sumpter, V. Muenier, H. Terrones, M. Terrones, and P.M. Ajayan, "Covalently Bonded Three-Dimensional Carbon Nanotube Solids via Boron Induced Nanojunctions," *Scientific Reports* **2** Article 363 (2012).

37. L. Liu, T.S. Kang, D.A. Cullen, L. Zhou, J. Kim, C.Y. Chang, E.A. Douglas, S. Jang, D.J. Smith, S.J. Pearton, W.J. Johnson, and F. Ren, "Effect of Source Field Plate on the Characteristics of Off-State, Step-Stressed AlGaN/GaN High Electron Mobility Transistors," *Journal of Vacuum Science & Technology B* **29**[3] Article 032204 (2011).

38. C.Y. Chang, E.A. Douglas, J. Kim, L. Lu, C.F. Lo, B.H. Chu, D.J. Cheney, B.P. Gila, F. Ren, G.D. Via, D.A. Cullen, L. Zhou, D.J. Smith, S. Jang, and S.J. Pearton, "Electric-Field-Driven Degradation in Off-State, Step-Stressed AlGaN/GaN High-Electron Mobility Transistors," *IEEE Transactions on Device and Materials Reliability* **11**[1] 187-193 (2011).

39. A. Sharma, N. Theodoropoulu, R. Loloee, W.P. Pratt, J. Bass, J.M. Zhang, M.A. Crimp, D.A. Cullen, D.J. Smith, K. Liu, S. Wang, and K. Xia, "Conduction Electron Scattering and Spin-Flipping at Sputtered Al/Cu Interfaces," *Journal of Applied Physics* **109**[5] Article 053903 (2011).

40. D.A. Cullen, K.L. More, K.S. Reeves, G.D. Vernstrom, L.L. Atanasoska, G.M. Haugen, and R.T. Atanasoski, "Characterization of Durable Nanostructured Thin Film Catalysts Tested Under Transient Conditions using Analytical Aberration-Corrected Electron Microscopy," *Polymer Electrolyte Fuel Cells 11 - ECS Transactions* **41**[1] 1099-1103 (2011).

41. C.F. Lo, C.Y. Chang, B.H. Chu, H.Y. Kim, J. Kim, D.A. Cullen, L. Zhou, D.J. Smith, S.J. Pearton, A. Dabiran, "Proton Irradiation Effects on AlN/GaN High Electron Mobility Transistors," *Journal of Vacuum Science & Technology B* **28**[5] L47-L51 (2010).

42. D.J. Smith, D.A. Cullen, L. Zhou, and M.R. McCartney, "Applications of TEM Imaging, Analysis, and Electron Holography to III-Nitride HEMT Devices," *Microelectronics Reliability* **50**[9-11] 1514-1519 (2010).

43. J.H. Leach, X. Ni, X. Li, M. Wu, Ü. Özgür, H. Morkoç, L. Zhou, D.A. Cullen, D.J. Smith, H. Cheng, Ç. Kurdak, J.R. Meyer, and I. Vurgaftman, "Bias Dependent Two-Channel Conduction in InAlN/AlN/GaN Structures," *Journal of Applied Physics* **107**[8] Article 083706 (2010).

44. M.R. McCartney, N. Agarwal, S. Chung, D.A. Cullen, M.G. Han, K. He, L.Y. Li, H. Wang, L. Zhou, and D.J. Smith, "Quantitative Phase Imaging of Nanoscale Electrostatic and Magnetic Fields Using Off-Axis Electron Holography," *Ultramicroscopy* **110**[5] 375-382 (2010).

45. J. Campos-Delgado, I.O. Maciel, D.A. Cullen, D.J. Smith, A. Jorio, M.A. Pimenta, H. Terrones, and M. Terrones, "Chemical Vapor Deposition Synthesis of N-, P-, and Si-Doped Single-Wall Carbon Nanotubes," *ACS Nano* **4**[3] 1696-1702 (2010).

46. F.A. Marino, D.A. Cullen, D.J. Smith, M.R. McCartney, and M. Saraniti, "Simulation of Polarization Charge on AlGaN/GaN High Electron Mobility Transistors – Comparison with Electron Holography," *Journal of Applied Physics* **107**[5] Article 054516 (2010).

47. J.M. Romo-Herrera, D.A. Cullen, E. Cruz-Silva, D. Ramirez, B.G. Sumpter, V. Meunier, H. Terrones, D.J. Smith, and M. Terrones, "The Role of Sulfur in the Synthesis of Novel Carbon Morphologies: From Covalent Y-Junctions to Sea-Urchin-Like Structures," *Advanced Functional Materials* **19**[8] 1193-1199 (2009).

48. A.G. Cano-Marquez, F.J. Rodríguez-Macias, J. Campos-Delgado, C.G. Espinosa-Gonzalez, F. Tristan-Lopez, D. Ramírez-Gonzalez, D.A. Cullen, D.J. Smith, M. Terrones, and Y.I. Vega-Cantu, " Ex-MWNTs: Graphene Sheets and Ribbons Produced by Lithium Intercalation and Exfoliation of Carbon Nanotubes," *Nano Letters* **8**[9] 1527-1533 (2009).

49. L. Zhou, D.A. Cullen, D.J. Smith, M.R. McCartney, A. Mouti, M. Gonschorek, E. Feltin, J.F. Carlin, and N. Grandjean, "Polarization Field Mapping of $Al_{0.85}In_{0.15}N$/AlN/GaN Heterostructure," *Applied Physics Letters* **94**[12] Article 121909 (2009).

50. D.A. Cullen and D.J. Smith, "Assessment of Surface Damage and Sidewall Implantation in AlGaN-Based High Electron Mobility Transistor Devices Caused During Focused-Ion-Beam Milling," *Journal of Applied Physics* **104**[9] Article 094304 (2008).

51. J. Campos-Delgado, J.M. Romo-Herrera, X.T. Jian, D.A. Cullen, H. Muramatsu, Y.A. Kim, T. Hayashi, Z.F. Ren, D.J. Smith, Y. Okuno, T. Ohba, H. Kanoh, K. Kaneko, M. Endo, H. Terrones, M.S. Dresselhaus, and M. Terrones, "Bulk Production of a New Form of sp(2) Carbon: Crystalline Graphene Nanoribbons," *Nano Letters* **8**[9] 2773-2778 (2008).

52. L. Chavez-Guerrero, R. Rangel-Mendez, E. Munoz-Sandoval, D.A. Cullen, D.J. Smith, H. Terrones, and M. Terrones, "Production and Detailed Characterization of Bean Husk-Based Carbon: Efficient Cadmium (II) Removal from Aqueous Solutions," *Water Research* **42**[13] 3473-3479 (2008).

53. E. Cruz-Silva, D.A. Cullen, L. Gu, J.M. Romo-Herrera, E. Munoz-Sandoval, F. Lopex-Urieas, B.G. Sumpter, V. Meunier, J.C. Charlier, D.J. Smith, H. Terrones, and M. Terrones, "Heterodoped Nanotubes: Theory, Synthesis, and Characterization of Phosphorus-Nitrogen Doped Multiwalled Carbon Nanotubes," *ACS Nano* 2[3] 441-448 (2008).

54. J.M. Romo-Herrera, B.G. Sumpter, D.A. Cullen, H. Terrones, E. Cruz-Silva, D.J. Smith, V. Meunier, and M. Terrones, "An Atomistic Branching Mechanism for Carbon Nanotubes: Sulfur as the Triggering Agent," *Angewandte Chemie - International Edition* **47**[16] 2948-2953 (2008).

55. B.G. Sumpter, V. Meunier, J.M. Romo-Herrera, E. Cruz-Silva, D.A. Cullen, H. Terrones, D.J. Smith, and M. Terrones, "Nitrogen-Mediated Carbon Nanotube Growth: Diameter Reduction, Metallicity, Bundle Dispersability, and Bamboo-Like Structure Formation," *ACS Nano* **1**[4] 369-375 (2007).

INVITED PRESENTATIONS

D.A. Cullen, *The Role of Aberration-corrected Electron Microscopy and Microanalysis in Developing Energy-related Materials*. Minnesota Microscopy Society Spring Symposium, St. Paul, MN (Apr. 1, 2015).

D.A. Cullen, *Research Experiences and Opportunities at Department of Energy National Laboratories.* BYU-Idaho Physics Colloquium, Rexburg, ID (Mar. 26, 2015).

D.A. Cullen, *Optimizing Fuel Cell Materials through Electron Microscopy and Microanalysis*. Annual Meeting of the Appalachian Regional Microscopy Society, Raleigh, NC (Nov. 15, 2013).

D.A. Cullen, H.M. Meyer III, K.S. Reeves, D.W. Coffey, and K.L. More, *Optimizing Fuel Cell Materials through Electron Microscopy and Microanalysis.* Microscopy & Microanalysis 2013, Indianapolis, IN (Aug. 4-8, 2013).

D.A. Cullen, K. Perry, and K.L. More. *Electron Microscopy Applied to Understanding Stability of Fuel Cell Materials.* 2012 Electrochemical Energy Storage and Conversion Forum, Knoxville, TN (April 19–20, 2012).

ACTIVITIES

- Workshop to Foster US-Brazilian Research Collaborations, Selected Participant, September 16-26, 2009, Rio de Janeiro, Brazil
- Professional Society Member/Fellows Committee: Microscopy Society of America
- Professional Society Member: The Electrochemical Society

HONORS AND AWARDS

- Appalachian Regional Microscopy Society Young Investigator Award (2013)
  Optimizing Fuel Cell Materials through Electron Microscopy and Microanalysis.
- Alvin M. Weinberg Fellow, Oak Ridge National Laboratory (2010)
  Advanced Electron Microscopy Studies of Energy-Related Catalysts.
- ARCS (Achievement Rewards for College Scientists) Scholar, Phoenix Chapter (2009)
  Characterization of GaN-Based High Electron Mobility Transistor Devices.

- Distinguished Scholar Award, Microbeam Analysis Society (2009)
  Polarization Field Mapping of AlGaN/GaN HEMT Devices using Lorentz-Mode Electron Holography.
- ORCA Undergraduate Research Grant Award, Brigham Young University (2005)
  Fingerprinting the α and γ Phases of Alumina using Electron Energy-Loss Spectroscopy.