

Hunter B. Andrews, Ph.D.
R&D Associate Staff
Isotope Applications Research Group
Radioisotope Science and Technology Division
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Education

Virginia Commonwealth University, Richmond, VA **May 2020**

Ph.D. in Mechanical and Nuclear Engineering

Thesis: *Development of Near-Real Time Material Detection and Analysis by Coupling Electrochemical & Optical Spectroscopy Methods for Molten Salt Systems*

Virginia Commonwealth University, Richmond, VA **May 2016**

B.S. in Mechanical Engineering with a Nuclear Concentration

Research Experience

R&D Staff – Analytical Chemist **2024 - Present**

Oak Ridge National Laboratory, Oak Ridge, TN

Isotope Applications Research Group

Research area(s): Currently my efforts revolve around the development of novel optical analytical methods for real-time monitoring in hazardous environments or the measurement of trace signatures in a high matrix background. While my main expertise lies in laser-induced breakdown spectroscopy (LIBS), I also am heavily involved in research related to inorganic mass spectrometry, multivariate modeling of spectroscopy data, molten salt research, and isotope production.

R&D Associate Staff **2021 – 2024**

Oak Ridge National Laboratory, Oak Ridge, TN

Isotope Applications Research Group

Research area(s): My efforts revolved around the development of novel optical spectroscopy tools (e.g., absorbance, fluorescence, laser-induced breakdown spectroscopy (LIBS), Raman) for real-time monitoring of processes occurring in hazardous environments such as radiological hot cells and gloveboxes or nuclear reactor applications. Additional research includes the development of analytical tools in the fields of particle detection, engineered enzymes, and environmental/biosciences.

Postdoctoral Research Assistant**2020 – 2021**

Oak Ridge National Laboratory, Oak Ridge, TN
Isotope Applications Research Group

Research area(s): As a postdoctoral researcher I developed a LIBS system to continually monitor the off gas evolved from a molten salt reactor. Here, advanced multivariate modeling and machine learning in Python were used to enhance the analysis of complex spectral data.

Research mentor: Kristian Myhre

Visiting Graduate Researcher**2019 – 2020**

Oak Ridge National Laboratory, Oak Ridge, TN
Radiochemical Science and Engineering Group

Research area(s): During the final year of my graduate studies, I performed research using LIBS techniques for advanced nuclear reactor applications and impurity analysis in aqueous solutions. These experimental studies were coupled with advanced data analysis in Python.

Research mentors: Kristian Myhre, Joanna McFarlane

Graduate Research Assistant**2016 – 2020**

Virginia Commonwealth University, Richmond, VA
Department of Mechanical and Nuclear Engineering

Research area(s): My graduate studies focused on the development of near-real time material detection and analysis by coupling electrochemical and optical spectroscopy methods for molten salt systems related to nuclear fuel reprocessing.

Research mentor: Supathorn Phongikaroon

Undergraduate Research Assistant**2015 – 2016**

Virginia Commonwealth University, Richmond, VA
Department of Mechanical and Nuclear Engineering

Research area(s): As an undergraduate I measured the electrochemical and thermodynamic properties of lanthanides (La, Gd) and actinides (U) in LiCl-KCl eutectic molten salts.

Research mentor: Supathorn Phongikaroon

Peer Reviewed Publications

(*denotes first or corresponding author [29], †denotes article featured on journal cover [12])

*45. T.A. Rush, A.M. Wymore, M. Rodríguez, Jr, S. Jawdy, R.J. Vilgalys, M.Z. Martin, **H.B. Andrews**. “Fungal Elemental Profiling Unleashed Through Rapid Laser-Induced Breakdown Spectroscopy (LIBS).” *mSystems*. 2024.

44. B.J. Riley, C.L. Beck, J.S. Evarts, S. Chong, A.M. Lines, H.M. Felmy, J. McFarlane, **H.B. Andrews**, S.A. Bryan, K.C. McHugh, and H.S. Cunningham. “Analytical Capabilities for Iodine Detection: Review of Possibilities for Different Applications.” *AIP Advances*. 2024. 14(8).

*43. **H.B. Andrews**, J. Moon, L.R. Sadergaski. “Leveraging Calibration Transfer Techniques for Remote Monitoring of Samarium and Europium in LiCl Using Laser-Induced Florescence Spectroscopy for Radioisotope Production Applications.” *Industrial & Engineering Chemistry Research*. 2024.

42. J. Moon, J. McFarlane, **H.B. Andrews**, K.R. Rob, M. Ross, D. Sulejmanovic, Y. Zhang, E. Stringfellow, C. Agca, J. Schorne-Pinto, T.M. Besmann. "Density Measurements of Molten LiF–BeF₂ and LiF–BeF₂–LaF₃ Salt Mixtures by Neutron Radiography." *ACS Omega*. 2024.

*41. B.T. Manard, C.D. Quarles Jr, V.C. Bradley, T.L. Spano, N.A. Zirakparvar, B.W. Ticknor, D.R. Dunlap, P. Cable-Dunlap, C.R. Hexel, **H.B. Andrews**. "Uranium Single Particle Analysis for Simultaneous Fluorine and Uranium Isotopic Determinations via Laser-Induced Breakdown Spectroscopy/Laser Ablation–Multicollector–Inductively Coupled Plasma–Mass Spectrometry." *Journal of the American Chemical Society*, 2024.

†40. T.L. Spano, **H.B. Andrews**, A. Miskowiec, T.N. Beiswenger, B.T. Manard. "Spatially Resolved Raman Spectroscopic Investigation of Uranyl Fluoride: A Case Study in the Importance of Instrument Optimization." *Applied Spectroscopy*, 2024.

*†39. V. C. Bradley, B. T. Manard, L. Hendriks, D. R. Dunlap, A. N. Bible, A. Sedova, P. Saint-Vincent, B. Sanders and **H. B. Andrews**. "Quantifying Platinum Binding on Protein-Functionalized Magnetic Microparticles using Single Particle-ICP-TOF-MS." *Analytical Methods*, 2024.

*38. L.R. Sadergaski, **H.B. Andrews**, D. Rai II, V.A. Anagnostopoulos. "Comparing Designed Training Sets to Optimize Multivariate Regression Models for Pr, Nd, and Nitric Acid Using Spectrophotometry." *Applied Spectroscopy Practica*. 2024.

†37. V.C. Bradley, J. Burleson, **H.B. Andrews**, C. Thompson, T.L. Spano, D.R. Dunlap, N.A. Zirakparvar, B.W. Ticknor, C.R. Hexel, B.T. Manard. "Mapping of uranium particles on J-type swipes with microextraction-ICP-MS." *Analyst*. 2024.

*36. L.R. Sadergaski, **H.B. Andrews**, B.A. Wilson, "Comparing Sensor Fusion and Multimodal Chemometric Models for Monitoring U(VI) in Complex Environments Representative of Irradiated Nuclear Fuel." *Analytical Chemistry*. 2024. 96: 1759-1766.

†35. E.H. Kwapis, J. Borrero, K.S. Latty, **H.B. Andrews**, S. Phongikaroon, K.C. Hartig. "Laser Ablation Plasmas and Spectroscopy for Nuclear Applications." *Applied Spectroscopy*. 2024. 78: 9-55.

*34. **H.B. Andrews**, J. McFarlane. "Novel Calibration Approach for Monitoring Aerosol Hydrogen Isotopes Using Laser-Induced Breakdown Spectroscopy for Molten Salt Reactor Off-Gas Streams." *Sensors*. 2023. 23: 9797.

33. L.R. Sadergaski, **H.B. Andrews**, S.E. Gilson, A.J. Parkison. "Quantifying Neptunium Oxidation States in Nitric Acid through Spectroelectrochemistry and Chemometrics." *Frontiers in Nuclear Engineering*. 2023. 2: 1323372.

*32. **H.B. Andrews**, C.D. Quarles Jr, V.C. Bradley, T. Spano, J.A. Petrus, B. Paul, N.A. Zirakparvar, D.R. Dunlap, C.R. Hexel, B.T. Manard. "Advancing Elemental and Isotopic Analysis of Uranium Mineral Inclusions: Rapid Screening via Laser-Induced Breakdown Spectroscopy and High-Resolution Laser Ablation-ICP-MS Mapping." *Microchemical Journal*. 2023. 109605.

*31. **H.B. Andrews**, A.M. Wymore, E. E. Wetter, E.M. Herndon, H. Li, S.A. Martin, N.A. Griffiths, X. Yang, W. Muchero, D.J. Weston, M.Z. Martin. "Rapid Screening of Wood and Leaf Tissues: Investigating Silicon-based Phytoliths in *Populus trichocarpa* for Carbon Storage Applications using Laser-Induced Breakdown Spectroscopy and Scanning Electron Microscopy–

Energy Dispersive X-Ray Spectroscopy.” *Journal of Analytical Atomic Spectrometry*. 2023. 38: 2353-2364.

30. A. Birri, N. Termini, P. Rose Jr., S. Chapel, **H.B. Andrews**, N.D.B. Ezell. “Development and demonstration of a rolling ball viscometer for molten salts with near-minimum liquidus NaCl–KCl.” *Thermal Science and Engineering Progress*. 2023. 44: 1020209.

†29. L.R. Sadergaski, B.T. Manard, **H.B. Andrews**. “Analysis of trace elements in uranium by inductively coupled plasma-optical emission spectroscopy, design of experiments, and partial least squares regression.” *Journal of Analytical Atomic Spectrometry*. 2023. 38(4): 800-809.

28. L.R. Sadergaski, S.B. Irvine, **H.B. Andrews**. “Partial least squares, experimental design, and near-infrared spectrophotometry for the remote quantification of nitric acid concentration and temperature.” *Molecules*. 2023. 28(7): 3224.

27. J. Moon, K. Myhre, **H.B. Andrews**, J. McFarlane. “Molybdenum-99 from molten salt reactor as a source of technetium-99m for nuclear medicine: past, current, and future of molybdenum-99.” *Nuclear Technology*. 2023. 209(6): 787-808.

26. J. McFarlane, **H.B. Andrews**, A.L. McAlister, J. Moon, K.R. Robb, C.F. Weber, A. Ballard. “The effect of interfacial phenomena on gas solubility measurements in molten salts.” *Frontiers in Energy Research*. 2023. 10: 2016.

*†25. B.T. Manard, V.C. Bradley, C.D. Quarles Jr, L. Hendriks, D.R. Dunlap, C.R. Hexel, P. Sullivan, **H.B. Andrews**. “Towards automated and high-throughput quantitative sizing and isotopic analysis of nanoparticles via single particle-ICP-TOF-MS.” *Nanomaterials*. 2023. 13(8): 1322.

*†24. B.T. Manard, **H.B. Andrews**, C.D. Quarles Jr, V.C. Bradley, P. Doyle, N.A. Zirkparvar, D.R. Dunlap, C.R. Hexel. “Exploration of LIBS as a novel and rapid elemental mapping technique of nuclear fuels in the form of surrogate TRISO particles.” *Journal of Analytical Atomic Spectrometry*. 2023.

*23. S. Irvine, **H.B. Andrews**, K. Myhre, J. Coble. “Radiative transition probabilities of neutral and singly ionized rare earth elements (La, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu) estimated by laser-induced breakdown spectroscopy.” *Journal of Quantitative Spectroscopy and Radiative Transfer*. 2023. 108486.

22. S. Bhagia, S. Kore, S. Wasti, J. Đurkovič, J. Kováč, X. Zhao, **H.B. Andrews**, M. Martin, N.C. Gallego, U. Vaidya. “3D printing of a recycled copolyester of terephthalic acid, cyclohexanedimethanol and tetramethylcyclobutane diol.” *Polymer Testing*. 2023. 118: 107916.

*21. **H.B. Andrews**, P.K. Thallapally, A.J. Robinson. “Monitoring xenon capture in a metal organic framework using laser-induced breakdown spectroscopy.” *Micromachines*. 2023. 14(1): 82.

*†20. **H.B. Andrews**, L.R. Sadergaski, S.K. Cary. “Pursuit of the ultimate regression model for samarium (III), europium (III), and LiCl using laser-induced fluorescence, design of experiments, and a genetic algorithm for feature selection.” *ACS Omega*. 2023.

*19. **H.B. Andrews**, L.R. Sadergaski. “Hierarchical modeling to enhance spectrophotometry measurements—overcoming dynamic range limitations for remote monitoring of neptunium.” *Chemosensors*. 2023. 11(5): 274.

- *18. **H.B. Andrews**, L.R. Sadergaski. “Leveraging visible and near-infrared spectroelectrochemistry to calibrate a robust model for vanadium (IV/V) in varying nitric acid and temperature levels.” *Talanta*. 2023. 259: 124554.
- *17. **H.B. Andrews**, K.G. Myhre, J. McFarlane. “Concept for an irradiation experiment to test a laser-induced breakdown spectroscopy off-gas sensor for molten salt systems.” *Frontiers in Energy Research*. 2023. 10(1).
- *16. **H.B. Andrews**, M.Z. Martin, A.M. Wymore, U.C. Kalluri. “Rapid in situ nutrient element distribution in plants and soils using laser-induced breakdown spectroscopy (LIBS).” *Plant and Soil*. 2023. 1-10.
15. L.R. Sadergaski, T.J. Hager, **H.B. Andrews**. “Design of experiments, chemometrics, and Raman spectroscopy for the quantification of hydroxylammonium, nitrate, and nitric acid.” *ACS omega*. 2022. 7(8): 7287-7296.
- †14. L.R. Sadergaski, **H.B. Andrews**. “Simultaneous quantification of uranium (VI), samarium, nitric acid, and temperature with combined ensemble learning, laser fluorescence, and Raman scattering for real-time monitoring.” *Analyst*. 2022. 147(18): 4014-4025.
- *†13. K.G. Myhre, **H.B. Andrews**, D. Sulejmanovic, C.I. Contescu, J.R. Keiser, N.C. Gallego. “Approach to using 3D laser-induced breakdown spectroscopy (LIBS) data to explore the interaction of FLiNaK and FLiBe molten salts with nuclear-grade graphite.” *Journal of Analytical Atomic Spectrometry*. 2022. 37(8): 1629-1641.
12. J. Moon, K. Myhre, **H.B. Andrews**, J. McFarlane. “Potential of electrolytic processes for recovery of molybdenum from molten salts for ⁹⁹Mo production.” *Progress in Nuclear Energy*. 2022. 152: 104369.
- *†11. J. Moon, **H.B. Andrews**, C. Agca, J.-C. Bilheux, A. Braatz, A. McAlister, J. McFarlane, J. McMurray, K. Robb, Y. Zhang. “Density measurements of various molten sodium, magnesium, potassium, and uranium chloride salt compositions using neutron imaging.” *Industrial & Engineering Chemistry Research*. 2022. 61(48): 17665-17673.
10. M. Martin, R.C. Martin, **H.B. Andrews**, S. Allman, D. Brice, S. Martin, N. Andre. “Quantification of rare earth elements in the parts per million range: a novel approach in the application of laser-induced breakdown spectroscopy.” *Applied Spectroscopy*. 2022. 76(8): 937-945.
- *9. S. Irvine, **H.B. Andrews**, K. Myhre, K. Goldstein, J. Coble. “Radiative transition probabilities of neutral and singly ionized Europium estimated by laser-induced breakdown spectroscopy (LIBS).” *Journal of Quantitative Spectroscopy and Radiative Transfer*. 2022. 286: 108184.
- *†8. **H.B. Andrews**, L.R. Sadergaski, K.G. Myhre. “Neptunium transition probabilities estimated through laser induced breakdown spectroscopy (LIBS) measurements.” *Journal of Analytical Atomic Spectrometry*. 2022. 37(4): 768-774.
- *7. **H.B. Andrews**, K.G. Myhre. “Quantification of lanthanides in a molten salt reactor surrogate off-gas stream using laser-induced breakdown spectroscopy.” *Applied Spectroscopy*. 2022. 76(8): 877-886.

- *6. **H.B. Andrews**, J. McFarlane, K.G. Myhre. “Monitoring noble gases (Xe and Kr) and aerosols (Cs and Rb) in a molten salt reactor surrogate off-gas stream using laser-induced breakdown spectroscopy (LIBS).” *Applied Spectroscopy*. 2022. 76(8): 988-997.
- *5. **H.B. Andrews**, J. McFarlane, A.S. Chapel, N.D.B. Ezell, D.E. Holcomb, D. de Wet, M.S. Greenwood, K.G. Myhre, S.A. Bryan, A. Lines. “Review of molten salt reactor off-gas management considerations.” *Nuclear Engineering and Design*. 2021. 385: 111529.
- *4. **H.B. Andrews**, S. Phongikaroon. “Electrochemical and laser-induced breakdown spectroscopy signal fusion for detection of UCl_3 - $GdCl_3$ - $MgCl_2$ in $LiCl$ - KCl molten salt.” *Nuclear Technology*. 2021. 207(4): 617-626.
- *3. **H.B. Andrews**, S. Phongikaroon. “Improvement of an experimental routine for electrochemical composition measurements of $SmCl_3$ in $LiCl$ - KCl eutectic salt systems.” *Nuclear Technology*. 2020. 206(4): 651-661.
- *2. **H.B. Andrews**, S. Phongikaroon. “Development of an experimental routine for electrochemical and laser-induced breakdown spectroscopy composition measurements of $SmCl_3$ in $LiCl$ - KCl eutectic salt systems.” *Nuclear Technology*. 2019. 205(7): 891-904.
- *1. **H.B. Andrews**, S. Phongikaroon. “Comparison of exchange current density acquisition methods for $LaCl_3$ in molten $LiCl$ - KCl eutectic salt.” *Journal of The Electrochemical Society*. 2018. 165(9): E412.

Conference Proceedings/Transactions Publications

3. S. Irvine, **H.B. Andrews**, K. Myhre, K. Lawson, and J. Coble. “Measurement of Transition Probabilities of Europium Using Laser Induced Breakdown Spectroscopy.” Transactions, American Nuclear Society Winter Meeting 2021, Washington D.C., November 2021.
2. **H.B. Andrews**, J. McFarlane, D. Holcomb, N.D.B. Ezell, K. Myhre, A. Lines, S. Bryan, and H. Felmy. “Sensor Technology for Molten Salt Reactor Off-gas Systems.” Proceedings, American Nuclear Society: NPIC & HMIT 2021, Providence, RI, June 2021.
1. **H.B. Andrews** and S. Phongikaroon. “Measurement of Exchange Current Density of $LaCl_3$ in $LiCl$ - KCl Eutectic.” Proceedings, 2017 International Congress on Advances in Nuclear Power Plants, Kyoto, Japan, April 2017.

Reports

14. L.R. Sadergaski, **H.B. Andrews**, J. Sharpe, K.G. Myhre, A.J. Parkison. “Evaluating Optical Techniques to Characterize Solid State Samples for the Pu-238 Supply Program.” Oak Ridge National Laboratory, ORNL/TM-2023/3254.
13. J. McFarlane, D. Orea, K. Robb, **H.B. Andrews**, T. Hguyen. “Design of Instrumentation for Noble Gas Transport in LSTL Needed for Model Development.” Oak Ridge National Laboratory, ORNL/TM-2023/3138.
12. B.T. Manard, V.C. Bradley, B.W. Ticknor, C.R. Hexel, S.C. Metzger, M. Adkisson, N.A. Zirakparvar, D. Dunlap, R. K. Marcus, J. Goodwin, **H.B. Andrews**. “Oak Ridge National

Laboratory and Clemson University Microextraction-ICP-MS Round-Robin study FY23 Report.” Oak Ridge National Laboratory, ORNL/TM-2023/3110.

11. **H.B. Andrews**, J. McFarlane. “Establishing Isotopic Measurement Capabilities using Laser-Induced Breakdown Spectroscopy for the Molten Salt Reactor Campaign.” Oak Ridge National Laboratory, ORNL/TM-2023/3067.

10. A. Birri, N. Termini, K. Garland, S. Chapel, **H.B. Andrews**, P. Rose Jr., N.D.B. Ezell. “FY23 Progress Report on Viscosity and Thermal Conductivity Measurements of Molten Salts.” Oak Ridge National Laboratory, ORNL/TM-2023/3048.

9. V.C. Bradley, J. Bursleson, **H.B. Andrews**, B.W. Ticknor, C.R. Hexel, C.V. Thompson, T.L. Spano, B.T. Manard. “Oak Ridge National Laboratory Microextraction-ICP-MS FY23 Annual Report.” Oak Ridge National Laboratory, ORNL/SPR-2023/3034.

8. N. A. Zirakparvar, B. Manard, B. Monteleone, **H.B. Andrews**, B. Ticknor, V. Bradley, S. Metzger, D. Dunlap, C.R. Hexel. “Mid-Year Report for: 24.1.3.4 - Quantification of Analytical Background from GSR Tabs during Microbeam Uranium Isotope Analysis.” Oak Ridge National Laboratory, ORNL/SPR-2023/2874.

7. L.R. Sadergaski, **H.B. Andrews**, A.J. Miskowicz, D.G. Abrecht, S.K. Schrell. “Characterizing PuO₂ Powder at ORNL for the Multi-Lab Plutonium Process Signatures Campaign FY22.” Oak Ridge National Laboratory, ORNL/TM-2023/2852.

6. **H.B. Andrews**, P.K. Thallapally, A.J. Robinson. “Monitoring Xenon Capture in Metal Organic Frameworks Using Laser-Induced Breakdown Spectroscopy.” Oak Ridge National Laboratory, ORNL/TM-2022/2690, PNNL-33374.

5. S.B. Irvine, **H.B. Andrews**, K.G. Myhre, J.B. Coble. “Development of Laser-Induced Breakdown Spectroscopy for the Californium-252 Supply Program.” Oak Ridge National Laboratory, ORNL/TM-2022/2689.

4. L.R. Sadergaski, **H.B. Andrews**, K. Wilson, S.L. Queern, R.D. Hunley. “Feasibility Study of Spectrophotometry to Support a Pm Production Program at ORNL.” Oak Ridge National Laboratory, ORNL/TM-2022/2505.

3. **H.B. Andrews**, J. McFarlane. “Characterization of Surrogate Molten Salt Reactor Aerosol Streams.” Oak Ridge National Laboratory, ORNL/TM-2021/2205.

2. **H.B. Andrews**, K. Myhre. “Investigating the Use of a Handheld Laser Induced Breakdown Spectroscopy Device for Beryllium Measurements.” Oak Ridge National Laboratory, ORNL/TM2021/205.

1. J. McFarlane, B. Riley, D. Holcomb, A. Lines, **H.B. Andrews**, S. Bryan, S. Chapel, N. Ezell, H. Felmy, M. Greenwood, P. Humrickhouse, and K. Myhre. “Molten Salt Reactor Engineering Study for Off-gas Management.” Oak Ridge National Laboratory, ORNL/TM-2020/1602.

Conference Presentations

(* denotes an invited presentation)

29. **H.B. Andrews** and J. McFarlane. “Expanding the Use of Laser-Induced Breakdown Spectroscopy for Molten Salt Reactor Off-Gas Streams to Isotopic Measurements.” Presentation, ACS Fall Meeting, Denver, CO, August 2024.
28. **H.B. Andrews**. “Impurity Analysis Using Laser-Induced Breakdown Spectroscopy for the Plutonium-238 Supply Program.” Presentation, Nuclear and Emerging Technology for Space (NETS), Santa Fe, NM, May 2024.
- *27. **H.B. Andrews**. “LIBS Across the Nuclear Fuel Cycle: From Monitoring Molten Salt Off-Gas Streams to Imaging Advanced Fuel Forms.” Presentation, The Latest Trends in Atomic Spectroscopy: A Virtual Symposium, March 2024.
- *26. **H.B. Andrews**, B.T. Manard, C.D. Quarles Jr., V.C. Bradley, P. Doyle, A.N. Zirakparvar, D.D. Dunlap, C.R. Hexel. “Advanced Nuclear Fuel Analysis: Exploring LIBS for Rapid Elemental Imaging of Surrogate TRISO Particles.” Presentation, Winter Conference on Plasma Spectrochemistry 2024, Tucson, AZ, January 2024.
25. **H.B. Andrews**. “Laser-Induced Breakdown Spectroscopy – A Versatile Tool for MSR Applications.” Presentation, MSR Workshop 2023, Oak Ridge, TN, October 2023. [View recording here.](#)
- *24. **H.B. Andrews**. “Overview of Laser-Induced Breakdown Spectroscopy Research at Oak Ridge National Laboratory.” Presentation, SciX 2023, Reno, NV, October 2023.
23. **H.B. Andrews**, P. Thallapally. “Detection and Management of Xenon in Support of Molten Salt Reactor Development.” Presentation, ACS Fall Meeting 2023, San Francisco, CA, August 2023.
- *22. **H.B. Andrews**, P. Thallapally. “Off-gas xenon detection and management in support of MSRs.” Presentation, Generation IV International Forum Webinar Series, Virtual, July 2023.
- *21. **H.B. Andrews**. “Laser-induced breakdown spectroscopy to support advanced nuclear reactor development.” Presentation, North American Workshop on Laser Ablation, Notre Dame, IN, June 2023.
20. **H.B. Andrews**, L. Sadergaski. “Multivariate chemometrics and spectrophotometry for the quantification of aqueous neptunium processing streams for the plutonium-238 supply program.” Presentation, 2023 Nuclear and Emerging Technology for Space, Idaho Falls, ID, May 2023.
- *19. **H.B. Andrews**. “Laser-induced breakdown spectroscopy in support of advanced nuclear reactor development.” Presentation, 2023 Photonics Spectra Spectroscopy Conference, Virtual, April 2023.
- *18. **H.B. Andrews**, K. Myhre, J. McFarlane, P. Thallapally. “Analysis of aerosols and gases relevant to molten salt reactor off-gas monitoring using laser-induced breakdown spectroscopy.” Presentation, 2022 Materials Research Society Conference, Boston, MS, December 2022.
- *17. **H.B. Andrews**, A. Wymore, X. Yang, W. Muchero, S. Martin, E. Herndon, N. Griffiths, G. Tuskan, D. Weston, M. Martin. “Quantification of silicon in poplar leaves and wood pellets via laser-induced breakdown spectroscopy.” Presentation, SciX 2022, Covington, OH, October 2022.
- *16. **H.B. Andrews**. “Recent applications of laser-induced breakdown spectroscopy at Oak Ridge National Laboratory.” Presentation, SciX 2022, Covington, OH, October 2022.

- *15. **H.B. Andrews**, K. Myhre, D. Sulejmanovic, J. McFarlane, J. Keiser, N. Gallego. “Application of laser-induced breakdown spectroscopy for the molten salt reactor campaign.” Presentation, 2022 Fall American Chemical Society, Chicago, IL, August 2022.
- *14. **H.B. Andrews**, J. McFarlane, A. S. Chapel, N.D.B. Ezell. “Development of laser induced breakdown spectroscopy sensor for molten salt reactor off-gas stream.” Presentation, 2021 MSR Workshop, Oak Ridge, TN, October 2021.
- *13. **H.B. Andrews**, K. Myhre, J. McFarlane, A. S. Chapel, N.D.B. Ezell. “Quantification of elements in a surrogate molten salt reactor off-gas stream.” Presentation, 2021 Fall American Chemical Society, Virtual, August 2021.
12. **H.B. Andrews**, J. McFarlane, D. Holcomb, N.D.B. Ezell, K. Myhre, A. Lines, S. Bryan, H. Felmy. “Sensor technology for molten salt reactor off-gas systems.” Presentation, American Nuclear Society: NPIC & HMIT 2021, Providence, RI, June 2021.
- *11. **H.B. Andrews**, K. Myhre, J. McFarlane, A. S. Chapel, N.D.B. Ezell, and G. Del Cul. “Analysis of aerosols and gases relevant to molten salt reactor off-gas monitoring using laser induced breakdown spectroscopy.” Presentation, 2020 Fall American Chemical Society, August 2020.
10. **H.B. Andrews**, S. Phongikaroon. “Application of electrochemical and laser spectroscopic methods for composition measurements of $\text{UCl}_3\text{-MgCl}_2\text{-GdCl}_3$ in LiCl-KCl molten salt.” Presentation, 2019 Fall American Chemical Society, San Diego, California, August 2019.
9. **H.B. Andrews**, S. Phongikaroon. “Application of electrochemical and laser spectroscopic methods for composition measurements of $\text{SmCl}_3\text{-GdCl}_3$ in LiCl-KCl molten salt.” Presentation, Southwest Institute of Nuclear Materials Management Meeting, Santa Fe, NM, May 2019.
8. **H.B. Andrews**, S. Phongikaroon. “Investigation of electrode withdrawal and laser-induced breakdown spectroscopy methods for concentration estimation of SmCl_3 in LiCl-KCl .” Poster, 2018 American Nuclear Society Winter Meeting, Orlando, Florida, November 2018.
7. **H.B. Andrews**, S. Phongikaroon. “The effect of temperature, concentration, electrode gap, and electrode depth on solution resistance of $\text{GdCl}_3\text{-LiCl-KCl}$ system.” Presentation, International Pyroprocessing Research Conference, Ibaraki, Tokai-Mura, Japan, October 2018.
6. **H.B. Andrews**, S. Phongikaroon. “Development of an experimental routine for electrochemical and laser-induced breakdown spectroscopy composition measurements of LiCl-KCl eutectic salts.” Presentation, 2018 American Nuclear Society Student Conference, Gainesville, Florida, April 2018.
5. **H.B. Andrews**, S. Phongikaroon. “Effect of concentration, temperature, and interelectrode gap on the voltage drop in an electrochemical system of $\text{GdCl}_3\text{-LiCl-KCl}$.” Presentation, Proceedings, 2017 American Nuclear Society Annual Meeting, San Francisco, California, June 2017.
4. **H.B. Andrews**, S. Phongikaroon. “Measurement of exchange current density of LaCl_3 in LiCl-KCl eutectic.” Presentation, Proceedings, 2017 International Congress on Advances in Nuclear Power Plants, Fukui and Kyoto, Japan, April 2017.
3. **H.B. Andrews**, S. Phongikaroon. “Comprehensive comparison of exchange current density acquisition methods in chloride salts.” Presentation, 2017 American Nuclear Society Student Conference, Pittsburgh, Pennsylvania, April 2017.

2. **H.B. Andrews**, S. Phongikaroon. “Comparison of experimental exchange current density acquisition methods for La/La³⁺ in LiCl-KCl eutectic salt.” Poster, 2016 American Nuclear Society Winter Meeting, Las Vegas, Nevada, November 2016.

1. **H.B. Andrews**, S. Phongikaroon. “Measurement and analysis of exchange current density of lanthanides in LiCl-KCl eutectic salt.” Presentation, 2016 American Nuclear Society Student Conference, Madison, Wisconsin, April 2016.

Mentorship Activities

Postdoctoral Researchers: Zechariah Kitzhaber (2024 – present)

Advisor/Committee Member: Peggy Milota (Ph.D.), Sawyer Irvine (M.S.)

Internship Students: David Rai II (B.S.), Evelyn Andrade (B.S.), Travis Hager (B.S.), Kyle Morgan (B.S.), Ivan Cano (B.S.), Brian Rodriguez (B.S.)

Related activities: Early Career Session (SciX 2023), Python short course (Summer 2023), Lightning talk mentor (GEM Program Summer 2022)

Skills

Optical Spectroscopy and Data Analysis

Fundamental knowledge of laser use for optical spectroscopy. In-depth experience with laser-induced breakdown spectroscopy, absorption spectroscopy, and laser induced fluorescence, along with univariate and chemometric modeling, for evaluating the composition of solids, liquids, aerosols, and molten salts.

Electrochemical Testing

Proficient experience utilizing techniques such as cyclic voltammetry, linear polarization, Tafel, open circuit potentiometry, and chronoamperometry for electrochemical property measurement and compositional analysis. Experience with spectroelectrochemical experiments as well.

Specialized Equipment Knowledge

Laser safety officer certification, Class 4 lasers, Nd:YAG lasers, Czerny-Turner spectrometers, Echelle spectrometers, Biologic VSP 300 potentiostat, inert/radiological glovebox systems, cascade impactor

Software Experience

Proficient with Python for data analysis, machine learning, and graphics. General experience with several spectroscopy and electrochemical data acquisition software including: LIBSsoft, Andor Solis, Ocean Optics, EC-Lab, Elveflow, iolite 4, and more. Experience with Adobe Illustrator for graphic generation.

Awards

People Choice for Best LDRD Project (ORNL)

2023

Early Career Award (Society of Applied Spectroscopy)	2023
3 rd Place in Laser Ablation Imaging Contest (NAWLA)	2023
Journal of Analytical Atomic Spectrometry Outstanding Reviewer Award	2023
UT-Battelle Outstanding Scholarly Output Award	2022
Your Science in a Nutshell (Lightning Talk) Winner	2022
ANS Fuel Cycle and Waste Management John D. Randall Scholarship	2019
Best Poster in Fuel Cycle and Waste Management (ANS Winter Conference)	2018
Innovations in Nuclear Technology R&D Award	2018
Top Paper Submission (ANS Student Conference)	2018
Best Presentation in Fuel Cycle and Waste Management (ANS Student Conference)	2018
Best Presentation in Fuel Cycle and Waste Management (ANS Student Conference)	2017
DOE Nuclear Energy University Program Graduate Research Fellowship	2016
Innovations in Fuel Cycle Research Award	2016

Professional Societies and Activities

American Nuclear Society (ANS)

Member	2016 – present
Student Conference Technical Co-Chair	2019
Program Chair (VCU Student Section)	2017

American Chemical Society (ACS)

Member	2019 – present
Co-Chair of Molten Salt Symposium	2020 – present

Society for Applied Spectroscopy (SAS)

Member	2021 – present
SciX NASLIBS Section Co-Chair	2023
SciX Atomic Section Co-chair	2024

Molten Salt Reactor Workshop (ORNL)

Lightning Talk Organizer	2023 – present
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Sensors (MDPI)

Special Issue Guest Editor (link)	2023 – 2024
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Frontiers in Nuclear Engineering (Frontiers)

Editorial Board Member, Review Editor	2023 – present
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Department of Nuclear Engineering VCU

Advisory Board Member 2024 – present

Materials Research Society (MRS)

Member 2022 – 2023

Institute of Nuclear Materials Management (INMM)

Member 2018-2020

President (VCU Student Section) 2018

Past President (VCU Student Section) 2019

The Electrochemistry Society

Member 2018 – 2019

References

Kristian Myhre, Ph.D.

R&D Staff, Radiochemical Science and Engineering Group

kmyhre@ornl.gov

Oak Ridge National Laboratory – Postdoctoral Mentor

Joanna McFarlane, Ph.D.

Distinguished R&D Staff, Fuel Cycle Chemical Technology Group

mcfarlanej@ornl.gov

Oak Ridge National Laboratory – Research Mentor

Supathorn Phongikaroon, Ph.D., P.E.

Associate Professor and Director, Nuclear Engineering Programs

spongikaroon@vcu.edu

Virginia Commonwealth University – Graduate Advisor