

Thomas M. Arruda, PhD

Assistant Professor
Department of Chemistry
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Professional Experience

2013-	Assistant Professor Chemistry Salve Regina University, Newport, RI
2010-2013	Postdoctoral Research Associate Center for Nanophase Material Sciences Oak Ridge National Laboratory, Oak Ridge, TN
2006-2009	Research Assistant Northeastern University, Boston, MA
2004-2006	Teaching Assistant, Chemistry Northeastern University, Boston, MA
2003-2004	Teaching Assistant, Chemistry University of Massachusetts, N. Dartmouth, MA

Education

Northeastern University (Boston, MA)
PhD in Chemistry, 29 January, 2010
Thesis in *physical* chemistry, advisor: Sanjeev Mukerjee
Title: X-ray absorption spectroscopy investigations into the stability and activity of fuel cell electrocatalysts

University of Massachusetts (N. Dartmouth, MA)
B.S. in Chemistry, Cum Laude, January 2004
Undergraduate research advisor: Russell R. Bessette
Research performed at the Naval Undersea Warfare Center, Newport, RI

Honors and Awards

2009	Chemistry Graduate Leadership Award (NU)
2004	Brian A. Rose Award (UMASS Dartmouth)
2003	American Chemical Society Analytical Division Award

Areas of Research Focus

1. *Ion dynamics of Li ion battery materials.*
We use Electrochemical Strain Microscopy (ESM) to map ion dynamics in Li ion battery cathode, anode and electrolyte materials on the nanoscale.
2. *Characterization and development of Li air battery materials.*
Force and strain based AFM methods are adapted to perform nanoscale electrochemical techniques (CV, CA, EIS) to study Li-air battery electrolytes in situ, with nanometer resolution.

3. *Redox behavior of metal porphyrins.*
Fundamental electrochemical and x-ray absorption spectroscopy studies of metal porphyrins for use as potential electrocatalysts for fuel cell related applications.
4. *Electrocatalysis of Solid Acid Fuel Cell Materials.*
Pd-Pt catalysts supported on CsH₂PO₄ electrolyte under development for SAFCs are being investigated by ESM and X-ray Absorption Spectroscopy.
5. Dynamics of vanadium ions for redox flow batteries (RFB).
We conduct fundamental experiments to understand vanadium ion crossover and dynamics for vanadium RFBs.

Teaching Experience

Instructor – CHM 114 General Chemistry 2: Salve Regina University 2013 (3 sections)
Instructor – CHM 113 General Chemistry 1: Salve Regina University 2013 (3 sections)
Instructor – General Chemistry Recitations: Northeastern University 2004-2006

- Honors Chemistry for Engineers (2 Semesters)
- Chemistry for Engineers (2 Semesters)
- Chemistry for Nursing Majors (2 Semesters)

Instructor – General Chemistry Laboratory: Northeastern University: 2005 Summer
Instructor – General Chemistry Laboratory: UMASS Dartmouth: 2003-2004

Professional Membership

- American Chemical Society
- Electrochemical Society

Research Publications

1. **Arruda, T. M.**; Lawton, J. S.; Kumar, A.; Unocic, R. R.; Kravchenko, I. I.; Zawodzinski, T. A.; Jesse, S.; Kalinin, S. V.; Balke, N., In Situ Formation of Micron-Scale Li-Metal Anodes with High Cyclability, *ECS Electrochem. Lett.*, **2014**, 3(1), A4-A7.
2. Yang, N.; Doria, S.; Kumar, A.; Hyuak Jang, J.; **Arruda, T. M.**; Tebano, A.; Jesse, S.; Ivanov, I. N.; Baddorf, A. P.; Strelcov, E.; Licoccia, S.; Borisevich, A. Y.; Balestrino, G.; Kalinin, S. V., Water-Mediated Electrochemical Nano-Writing on Thin Ceria Films, *Nanotechnology*, **2014**, 25(7), 075701.
3. Doria, S.; Yang, N.; Kumar, A.; Jesse, S.; Tebano, A.; Aruta, C.; Di Bartolomeo, E.; **Arruda, T. M.**; Kalinin, S. V.; Licoccia, S.; Balestrino, G., Nanoscale Mapping of Oxygen Vacancy Kinetics in Nanocrystalline Samarium Doped Ceria Thin Films, *Appl. Phys. Lett.*, **2013**, 103, 171605.
4. Dubourdieu, C.; Bruley, J.; **Arruda, T. M.**; Posadas, A.; Jordan-Sweet, J.; Frank, M. M.; Cartier, E.; Frank, D. J.; Kalinin, S. V.; Demkov, A.; Narayanan, V., Ferroelectric Switching of Epitaxial BaTiO₃ films on Silicon Without Conducting Bottom Electrode, *Nature Nanotech.*, **2013**, 8(10), 478-754.

5. Kumar, A.; Chen, C.; **Arruda, T. M.**; Jesse, S.; Ciucci, F.; Kalinin, S. V., Frequency Spectroscopy of Irreversible Electrochemical Nucleation Kinetics on the nanoscale, *Nanoscale*, **2013**, 5, 11964-11970.
6. **Arruda, T. M.**; Kumar, A.; Jesse, S.; Veith, G. M.; Tselev, A.; Baddorf, A. P.; Balke, N.; Kalinin, S. V., Towards Quantitative Electrochemical Measurements on the Nanoscale by Scanning Probe Microscopy: Environmental and Current Spreading Effects, *ACS Nano*, **2013**, 7(9), 8175-8182.
7. Kumar, A.; **Arruda, T. M.**; Tselev, A.; Ivanov, I. N.; Lawton, J. S.; Zawodzinski, T. A.; Butyaev, O.; Zayats, S.; Jesse, S.; Kalinin, S. V., Nanometer-scale Mapping of Irreversible Electrochemical Nucleation Processes on Solid Li-ion Electrolytes, *Sci. Rep.*, **2013**, 3, 1621-8.
8. **Arruda, T. M.**; Heon, M.; Presser, V.; Hillesheim, P. C.; Dai, S.; Gogotsi, Y.; Kalinin, S. V.; Balke, N., In Situ Tracking of the Nanoscale Expansion of Porous Carbon Electrodes, *Energy Environ. Sci.*, **2013**, 6(1), 225-231.
9. Kalinin, S. V.; Kim, Y.; Kumar, A.; Strelcov, E.; Balke, N.; **Arruda, T. M.**; Jesse, S.; Leonard, D.; Borisevich, A., Electrochemical Strain Microscopy: Probing Electrochemical Transformations in Nanoscale Volumes, *Microsc. Today*, **2012**, 20(6), 10-15.
10. Balke, N.; Tselev, A.; **Arruda, T. M.**; Jesse, S.; Chu, Y-H.; Kalinin, S. V., Probing Local Electromechanical Effects in Highly Conductive Electrolytes, *ACS Nano*, **2012**, 6(11), 10139-10146.
11. **Arruda, T. M.**; Kumar, A.; Kalinin, S. V.; Jesse, S., The partially reversible formation of Li-metal particles on a solid Li electrolyte: Applications toward nanobatteries, *Nanotechnology*, **2012**, 23(32), 325402.
Feature article written: <http://phys.org/news/2012-08-explore-li-air-battery-reversibility-nanoscale.html>
12. Kramm, U. I.; Herranz, J.; Larouche, N.; **Arruda, T. M.**; Lefevre, M.; Jaouen, F.; Bogdanoff, P.; Fiechter, S.; Abs-Wurnbach, I.; Mukerjee, S.; Dodelet, J-P., Structure of the catalytic sites in Fe/N/C-catalysts for O₂-reduction in PEM fuel cells, *Phys. Chem. Chem. Phys.*, **2012**, 14(33), 11673-11688.
13. Jesse, S.; Kumar, A.; **Arruda, T. M.**; Kim, Y.; Kalinin, S. V.; Ciucci, F., Electrochemical strain microscopy: Probing ionic and electrochemical phenomena in solids at the nanometer level, *MRS Bull.*, **2012**, 37(7), 651-658.
14. Kumar, A.; **Arruda, T. M.**; Kim, Y.; Ivanov, I. N.; Jesse, S.; Bark, C. W.; Bristowe, N. C.; Artacho, E.; Littlewood, P. B.; Eom, C. -B.; Kalinin, S. V., Probing Surface and Bulk Electrochemical Processes on the LaAlO₃-SrTiO₃ Interface, *ACS Nano*, **2012**, 6(5), 3841-3852.

15. Kalinin, S. V., Kumar, A., Balke, N., McCorkle, M., Guo, S., **Arruda, T.** and Jesse, S. ESM of Ionic and Electrochemical Phenomena on the Nanoscale, *Adv. Mater. Proc.*, **2011**, 169(11), 30-34.
16. Kalinin, S. V.; Balke, N.; Jesse, S.; Tselev, A.; Kumar, A.; **Arruda, T. M.**; Guo, S.; Proksch, R., Electrochemical Strain Microscopy of Li-ion Conductive Materials for Energy Generation and Storage, *Mater. Today*, **2011**, 14(11), 548-558.
17. **Arruda, T. M.**; Kumar, A.; Kalinin, S. V.; Jesse, S., Mapping Irreversible Electrochemical Processes on the Nanoscale: Ionic Phenomena in Li-ion Conductive Glass Ceramic, *Nano Lett.*, **2011**, 11(10), 4161-4167.
18. Herranz, J.; Jaouen, F.; Lefevre, M.; Kramm, U. I.; Proietti, E.; Dodelet, J.-P.; Bogdanoff, P.; Fiechter, S.; Abs-Wurmbach, I.; Bertrand, P.; **Arruda, T. M.**; Mukerjee, S., Unveiling N-Protonation and Anion-Binding Effects on Fe/N/C Catalysts for O₂ reduction in Proton-Exchange-Membrane Fuel Cells, *J. Phys. Chem. C*, **2011**, 115 (32), 16087-16097.
19. Audette, G. F.; Lombardo, S.; Dudzik, J.; **Arruda, T. M.**; Kolinski, M.; Filipek, S.; Mukerjee, S.; Kannan, A. M.; Thavasi, V.; Ramakrishna, S.; Chin, M.; Somasundaran, P.; Viswanathan, S.; Keles, R. S.; Renugopalakrishnan, R., Protein Hot Spots at Bio-Nano Interfaces, *Mater. Today*, **2011**, 14(7-8), 292-298.
20. Gillette, S. M., Geiler, A. L., Chen, Z., Chen, Y., **Arruda, T.**, Xie, C., Wang, L., Zhu, X., Liu, M., Mukerjee, S., Vittoria, C., Harris, V. G., Active tuning of a microstrip hairpin-line microwave bandpass filter on a polycrystalline yttrium iron garnet substrate using small magnetic fields, *J. Appl. Phys.*, **2011**, 109, 07A513.
21. **Arruda, T. M.**; Shyam, B.; Lawton, J. S.; Ramaswamy, N.; Budil, D. E.; Ramaker, D. E.; and Mukerjee, S., Fundamental Aspects of Spontaneous Cathodic Deposition of Ru onto Pt/C Electrocatalysts and Membranes under Direct Methanol Fuel Cell Operating Conditions: An In situ X-ray Absorption Spectroscopy and Electron Spin Resonance Study, *J. Phys. Chem. C*, **2010**, 114(2), 1028-1040.
22. Shyam, B.; **Arruda, T. M.**; Mukerjee, S. and Ramaker, D.E., Effect of RuO_xH_y Particles Size on Particle Aging in Methanol, *J. Phys. Chem. C.*, **2009**, 113(45), 19713-19721.
23. Ramaswamy, N.; **Arruda, T. M.**; Wen, W.; Hakim, N.; Saha, M.; Gulla, A.; Mukerjee, S., Enhanced Activity and Interfacial Durability Study of Ultra Low Pt Based Electrocatalysts Prepared by Ion Beam Assisted Deposition (IBAD) Method, *Electrochim. Acta*, **2009**, 54,(26), 6756-6766.
24. Mukerjee, S.; Ziegelbauer, J.; **Arruda, T.**; Ramaker, D.E.; Shyam, B., Understanding Electrocatalytic Pathways in Low and Medium Temperature Fuel Cells: Synchrotron-based in Situ X-ray Absorption Spectroscopy, *ECS Interface*, **2008**, 17(4), 46.

25. **Arruda, T. M.**; Shyam, B.; Ziegelbauer, J. M.; Ramaker, D. E.; Mukerjee, S., Investigation into the Competitive and Site-Specific Nature of Anion Adsorption on Pt Using In Situ X-ray Absorption Spectroscopy, *J. Phys. Chem. C*, **2008**, 112(46), 18087-18097.
26. **Arruda, T. M.**; Chakraborty, L.; Lawton, J. S.; Calabrese-Barton, S.; Atanassov, P.; Mukerjee, S., Direct Observation of Oxygen Binding and Reduction in Laccase (T. versicolor) by In Situ X-ray Absorption Spectroscopy, **2013**, Submitted.

Book Chapters

1. Mukerjee, S.; **Arruda, T. M.**; Ziegelbauer, J.; Artyushkova, K.; Atanassov, P., In Situ X-ray Spectroscopy of Enzymatic Catalysis: Laccase-Catalyzed Oxygen Reduction, Chapter 15, *Enzymatic Fuel Cells: From Fundamentals to Applications*, H. Luckarift, P. Atanassov, G. Johnson (Eds). **2014**, In Press.
2. **Arruda, T. M.**; Balke, N.; Jesse, S.; Kalinin, S. V., Ch. 15 - Electrochemical Strain Microscopy of Li-ion and Li-air Battery Materials, *Scanning Probe Microscopy for Energy Research*, World Scientific Press, **2013**.
3. Mukerjee, S. and **Arruda, T.**, In Situ Spectroscopic Studies of Electrocatalysis on Highly Dispersed Nano-Materials, *Theory and Experiment in Electrocatalysis*, Modern Aspects of Electrochemistry 50, Springer Science, **2010**.

Conference Proceedings

1. **Arruda, T. M.**, Shyam, B., Ziegelbauer, J. M., Ramaker, D., Mukerjee, S., In situ XAS Investigation of Electrocatalyst Poisoning by Halides, *ECS Transactions*, **2007**, 11(1) 903-911.
2. Shyam, B., **Arruda, T.**, Ziegelbauer, J. M., Mukerjee, S., Ramaker, D. E., Observation of PtRu Particle Aging in Methanol with X-ray Absorption Spectroscopy, *ECS Transactions*, **2007**, 11(1), 1359.
3. Bessette, R. R., **Arruda, T. M.**, Patrissi, C. J., Tucker, S. P., Carreiro, L. G., Medeiros, M. G., Deschenes, C. M., Catalysis, Architecture and the Electrochemical Performance of Microfibrous Cathodes for Hydrogen Peroxide-Based Fuel Cells, *Proceedings of the Power Sources Conference*, 41st, 424-427, **2004**.

Patents

1. Jesse, S.; Kumar, A.; **Arruda, T.**; Kalinin, S., Method for local probing of irreversible electrochemical reactions and bias- and temperature- induced transformations, US Patent disclosure filed, **2011**.
2. Patrissi, C. J., Bessette, R. R., Carreiro, L. G., Kim, Y. K., **Arruda, T. M.**, Deschenes, C. M., Method for Increasing Fiber Density in Electrostatic Flocking, U. S. Patent 7,354,626, **2008**.

Presentations

1. 'Nanoscale Characterization of CDC Supercapacitors by In Situ Scanning Probe Microscopy Methods,' **T. M. Arruda**, M. Heon, V. Presser, Y. Gogotsi and N. Balke, *Symposium on Electrochemical Capacitors (B2)*, # 603, 222th Meeting of the Electrochemical Society, Honolulu, HI, **2012**.
2. 'Electrochemical Strain Spectroscopy: Monitoring Partially Reversible Electrochemical Processes in situ on Li-Air Battery Electrolytes,' **T. M. Arruda**, A. Kumar, S. V. Kalinin and S. Jesse, *Symposium on Metal Air Batteries (B4)*, # 1170, 222th Meeting of the Electrochemical Society, Honolulu, HI, **2012**.
3. 'Partially Reversible Electrochemistry on the Surface of Lithium Ion Conducting Glass Ceramic by Electrochemical Strain Microscopy,' **T. M. Arruda**, A. Kumar, S. Jesse and S. V. Kalinin, *Symposium on Nanotechnology General Session (A4)*, #108, 221st Meeting of the Electrochemical Society, Seattle, WA, **2012**.
4. 'Irreversible Conduction of Lithium Ions in Lithium Ion Conducting Glass Ceramic on the Nanoscale by Electrochemical Strain Microscopy,' **T. M. Arruda**, A. Kumar, S. V. Kalinin and S. Jesse, *Symposium on Electrochemistry on Nanoscale Dimensions 2 (I4)*, # 2524, 220th Meeting of the Electrochemical Society, Boston, MA, **2011**.
5. 'In Situ Investigations into the Interaction of Laccase and Os Mediators for Biological Fuel Cells', **T. Arruda**, Deboleena Chakraborty, S. C. Barton and S. Mukerjee, *Symposium on Physical, Analytical and Spectro-Electrochemical Characterization (II)*, #2759, 214th Meeting of the Electrochemical Society, Honolulu, HI, **2008**
6. 'In Situ XAS Investigation of Novel Osmium-Based Redox Polymer Mediators for Laccase-Based Biological Fuel Cells', **T. Arruda**, Deboleena Chakraborty, S. C. Barton and S. Mukerjee, *Symposium on Biological Fuel Cells 3 (B3)*, #249, 213th Meeting of the Electrochemical Society, Phoenix, AZ, **2008**
7. 'The Spontaneous Deposition of Ru Onto Pt/C Electrocatalyst: An In-Situ XAS Study', **T. Arruda**, B. Shyam, V. Murthi, D. Ramaker and S. Mukerjee, *Symposium of Fundamentals of Energy Storage and Conversion (B5)*, #312, 213th Meeting of the Electrochemical Society, Phoenix, AZ, **2008**
8. 'In Situ XAS Investigation of Electrocatalyst Poisoning by Halides', **T. Arruda**, J. Ziegelbauer, B. Shyam, D. Ramaker and S. Mukerjee, *Symposium on Proton Exchange Membrane Fuel Cells 7 (B10)*, #443, 212th Meeting of the Electrochemical Society, Washington DC, **2007**

Invited Talks

'Probing Irreversible Reactions in Li-air Batteries,' 3rd *International Workshop on Nanoscale Imaging for Energy Applications*, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory, Oak Ridge, TN, September 11-13, **2012**

'XAS and EPR Investigations of Laccase as a Potential Electrocatalyst for Biological Fuel Cells', T. Arruda, *National Synchrotron Light Source Seminar*, National Synchrotron Light Source, Brookhaven National Laboratory, Upton, NY, November, **2008**