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# Corey T. Love, Ph.D.

*Materials Research Engineer, NP-III*

U.S. Naval Research Laboratory

Alternative Energy Section, Chemistry Division

 <http://www.linkedin.com/pub/corey-love/5/b48/143>

 [http://www.researchgate.net/profile/corey\\_love](http://www.researchgate.net/profile/corey_love)

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## EDUCATION

**Ph.D., Materials Science and Engineering** 2008

*University of California-San Diego*

Dissertation title: "Cathodic Disbondment Resistance with Reactive Ethylene Terpolymer Blends and Composite Coatings"

**M.S., Materials Science and Engineering** 2004

*University of California-San Diego*

**B.S., Materials Science and Engineering** 2003

*Virginia Polytechnic Institute and State University*

## RESEARCH EXPERIENCE

**Materials Research Engineer**, Alternative Energy Section (2009 – Present, 5 years 8 months)

*U.S. Naval Research Laboratory*

Principal investigator on basic and applied research programs involving materials discovery, *in-situ* characterization and safety of lithium-ion batteries. Total research funding raised to date: \$925,000.

- PI of ONR-funded basic research program to identify mechanisms responsible for the formation and growth of lithium dendrites in Li-ion batteries and their propensity to cause internal short-circuits.
- Invented a single-point impedance spectroscopy methodology to probe the state-of-health of lithium-ion batteries resulting in domestic and international patent applications.
- Developed experimental procedure to use Cs-ions as tracers to identify constituent compounds of the solid electrolyte interface (SEI) layer on electrode materials.
- First to identify mechanical properties and durability of polymer separators used in commercial lithium-ion batteries. Publication cited 23 times since 2011.
- Characterized fundamental science of conduction at the nanoscale between battery electrode materials and liquid electrolytes. Studied the effect of atomic layer deposition on performance and safety of materials in electrochemical environments.
- Forged collaboration with Colorado School of Mines to build physics-based models used to predict electrochemical impedance signatures as indicators of battery performance and health.

**Post-Doctoral Fellow**, Alternative Energy Section (2008 – 2009, 10 months)

*U.S. Naval Research Laboratory*

Synthesis and characterization of lithium intercalation compounds for rechargeable lithium-ion battery cathodes and anodes.

- Synthesized highly lithiated transition metal oxides via high temperature solid-state and micro-emulsion techniques for high energy lithium-ion cathode materials.
- Produced experimental evidence to support theoretical calculations regarding capacity fade.
- Employed high energy X-ray diffraction and X-ray absorption spectroscopy techniques to identify structural and chemical instabilities in lithium intercalation materials.

**Graduate Research Assistant**, Materials Science and Engineering (2003 – 2008, 4 years 5 months)  
*University of California-San Diego*

Executed all aspects of materials research: experimental design, data collection, analysis and publication writing.

- Identified polymer blend and nanocomposite strategy to improve adhesion of coatings to metallic substrates with cathodic protection in corrosive environments.
- Developed testing protocol to measure adhesive strength and rate of delamination of polymer coatings in a single experiment.
- Employed full suite of thermal and mechanical analysis techniques to characterize strength, adhesion, degradation and durability of polymer and composite materials used as anti-corrosion coatings.

## ACADEMIC EXPERIENCE

**Lecturer**, Introduction to Materials Science and Engineering (2007, 1 semester)  
*University of San Diego*

- Participated in all aspects of classroom teaching: planned and presented lectures, devised homework problems and exams.

**Teaching Assistant**, Structural Materials (2007, 1 semester)  
*University of California-San Diego*

- Presented lectures and administered weekly problem-solving sessions. Planned laboratory experiments and graded laboratory reports.

**Teaching Assistant**, Design of Composite Structures (2007, 1 semester)  
*University of California-San Diego*

- Devised laboratory experiments and demonstrated proper techniques for injection molding of thermoplastics and wet layup of fiberglass-reinforced thermoset polymer composites.

## AWARDS AND HONORS

- Naval Research Laboratory, Top 20 Accomplishment of 2011 2011
- American Society of Naval Engineers, Elected Member 2011
- Naval Research Laboratory, Chemistry Division Young Investigator Award 2010
- Naval Research Laboratory, Jerome Karle Fellowship Recipient 2009
- ASEE Post-Doctoral Fellowship 2008
- National Association of Corrosion Engineers, "Travel Assistance Scholarship" 2007
- University of California-San Diego, "Graduate Research Expo Library Award" 2005
- University of Maryland, Summer Undergraduate Research Fellowship 2001
- Naval Research Laboratory, "Special Act Award" 2000

## PUBLICATIONS

### Refereed Journal Articles

1. W. Dmowski, T. Egami, K.E. Swider-Lyons, **C.T. Love** and D.R. Rolison, "Local Atomic Structure and Conduction Mechanism of Nanocrystalline Hydrous RuO<sub>2</sub> from X-ray Scattering," *Journal of Physical Chemistry B*, 106 (49), 12677-12683 (2002). Times cited: 192.
2. K.E. Swider-Lyons, **C.T. Love** and D.R. Rolison, "Improved Lithium Capacity of Defective V<sub>2</sub>O<sub>5</sub> Materials," *Solid State Ionics*, 152-153 Part A Special Issue, 99-104 (2002).
3. K.E. Swider-Lyons, **C.T. Love** and D.R. Rolison, "Selective Vapor Deposition of Hydrous RuO<sub>2</sub> Thin Films," *Journal of the Electrochemical Society*, 152(3), C158-C162 (2005).
4. **C.T. Love**, G. Xian and V.M. Karbhari, "Thermal, Mechanical and Adhesive Properties of HDPE/Reactive Ethylene Terpolymer Blends," *Journal of Applied Polymer Science*, 104(1), 331-338 (2007).
5. **C.T. Love**, G. Xian and V.M. Karbhari, "Cathodic Disbondment Resistance with Reactive Ethylene Terpolymer Blends," *Progress in Organic Coatings*, 60(4), 287-296 (2007).
6. **C.T. Love** and V.M. Karbhari, "Filled Reactive Ethylene Terpolymer Primers for Cathodic Disbondment Mitigation," *Journal of Applied Polymer Science*, 110(3), 1531-1544 (2008).
7. **C.T. Love**, W. Dmowski, M.J. Johannes, K.E. Swider-Lyons, "Structural Originations of Irreversible Capacity Loss from Highly Lithiated Copper Oxides," *Journal of Solid State Chemistry*, 184(9), 2412-2419 (2011).
8. **C.T. Love**, "Thermomechanical Analysis and Durability of Commercial Micro-porous Polymer Li-ion Battery Separators," *Journal of Power Sources*, 196, 2905-2912 (2011).
9. **C.T. Love** and K.E. Swider-Lyons, "Impedance Diagnostic for Overcharged Lithium-ion Batteries," *Electrochemical and Solid-State Letters*, 15(4), A53-A56 (2012).
10. C.J. Patridge, **C.T. Love**, K.E. Swider-Lyons, M.E. Twigg and D.E. Ramaker, "In-situ X-ray Absorption Spectroscopy Analysis of Capacity Fade in Nanoscale-LiCoO<sub>2</sub>," *Journal of Solid State Chemistry*, 203, 134-144 (2013).
11. **C.T. Love**, A. Korovina, C.J. Patridge, K.E. Swider-Lyons, M.E. Twigg and D.E. Ramaker, "Review of LiFePO<sub>4</sub> Phase Transition Mechanisms and New Observations from X-ray Absorption Spectroscopy," *Journal of the Electrochemical Society*, 160(5), A3153-A3161 (2013).
12. **C.T. Love**, M. Virji, R. Rocheleau and K.E. Swider-Lyons, "State-of-Health Monitoring 18650 4S Packs with a Single-Point Impedance Diagnostic," *Journal of Power Sources*, 266, 512-519 (2014).
13. **C.T. Love**, O.A. Baturina and K.E. Swider-Lyons, "Observation of Lithium Electrodeposits at Ambient Temperature and Below," *ECS Electrochemical Letters*, 4(2), A24-27 (2015).
14. M.D. Johannes, K.E. Swider-Lyons and **C.T. Love**, "Oxygen Character of Density of States as an Indicator of the Stability of Li-ion Battery Cathode Materials," *Journal of Physical Chemistry C*, submitted.
15. K.P. Fears, M. Gonzalez-Begne, **C.T. Love**, D.E. Day, and H. Koo, "Conformation and Activity of Glucosyltransferase Adsorbed on Saliva-coated Hydroxyapatite," *Langmuir*, submitted.
16. K. P. Fear, **C.T. Love**, and D. E. Day, "Protein Aggregation Induced by Nanostructured Apatites," *Biomaterials*, submitted.
17. C.J. Patridge, **C.T. Love** and D.E. Ramaker, "Utilization of Heavy Alkali Dopants as a Beacon to Study Cathode SEI Formation in Lithium-ion Batteries," *Journal of the Electrochemical Society*, submitted.

18. N.S. Spinner, **C.T. Love**, S.L. Rose-Pehrsson and S.G. Tuttle, "Expanding the Operational Limits of the Single-Point Impedance Diagnostic for Internal Temperature Monitoring of Lithium-ion Batteries," *Electrochimica Acta*, submitted.

### Conference Proceedings

1. K.E. Swider-Lyons, K.M. Bussmann, D.L. Griscom, **C.T. Love**, D.R. Rolison, W. Dmowski, T. Egami, "A New Nanocomposite Model for Hydrous RuO<sub>2</sub>," Solid State Ionic Devices II-Ceramic Sensors, The Electrochemical Society, Pennington, NJ, PV2000-32, 148-156 (2000).
2. K.E. Swider-Lyons, D.W. Weir, **C.T. Love**, R. Modi, T. Sutto, A. Pique, D.B. Chrisey, "Direct-Write Microbatteries as Integrated Power Sources for Microelectronic Devices," Power Sources for the New Millennium, The Electrochemical Society, Pennington, NJ, PV2002-22, 272-276 (2000).
3. A. Pique, K.E. Swider-Lyons, D.W. Weir, **C.T. Love**, R. Modi, "Laser Direct Writing of Microbatteries for Integrated Power Electronics," in Laser Applications in Microelectronics and Optoelectronics Manufacturing VI, SPIE Proceedings 4274, 316-322 (2001).
4. **C.T. Love**, K.E. Swider-Lyons and D.R. Rolison, "Thin Film Pt-RuO<sub>x</sub>H<sub>y</sub> electrodes for Direct Methanol Fuel Cells," in Direct Methanol Fuel Cells, The Electrochemical Society, Pennington, NJ PV2001-4, 42-49 (2001).
5. **C.T. Love**, G. Xian and V.M. Karbhari, "Adhesion and Characterization of High Density Polyethylene/Elvaloy Blends for Hot Melt Coating of Steel," Proceedings of the American Society for Composites, 20<sup>th</sup> Technical Conference, Philadelphia, PA, September 2005.
6. **C.T. Love**, G. Xian and V.M. Karbhari, "Hot Melt Bonding Anti-Corrosion Coating for Steel with Application for Rehabilitation," Proceedings of the Caltrans Bridge Research Conference, Sacramento, CA, October 31-November 1, 2005.
7. **C.T. Love** and V.M. Karbhari, "High Density Polyethylene/Reactive Ethylene Terpolymer Composites for Strengthening Steel Structures," Proceedings of SAMPE, Long Beach, CA, April 20-May 4, 2006.
8. **C.T. Love**, G. Xian and V.M. Karbhari, "Dual Functionality Reactive Ethylene Terpolymer Blends for Improving Cathodic Disbondment Performance of Polyethylene Coatings," American Chemical Society, San Francisco, CA, September 10-14, 2006.
9. **C.T. Love** and V.M. Karbhari, "Improved Cathodic Disbondment Performance with HDPE/RET Polymer Blends," American Society for Composite Materials, 21<sup>st</sup> Technical Conference, Dearborn, MI, September 17-20, 2006.
10. **C.T. Love**, A. Gapin and V.M. Karbhari, "Interfacial Adhesion in Multi-Walled Carbon Nanotube/Reactive Ethylene Terpolymer Composites," Proceedings of SAMPE, Baltimore, MD, June 4-7, 2007.
11. **C.T. Love**, G. Xian and V.M. Karbhari, "Wet Adhesion and Cathodic Disbondment in Thermoplastic Blend Coatings," Proceedings of SAMPE 2007, Baltimore, MD, June 3-7, 2007.
12. **C.T. Love**, A. Gapin and V.M. Karbhari, "Multi-Walled Carbon Nanotube Reactive Thermoplastic Composite Adhesives," 1<sup>st</sup> International Conference on Nanopolymers, Berlin, Germany, June 12-13, 2007.
13. **C.T. Love**, M.D. Johannes, A.M. Stux, and K.E. Swider-Lyons, "Characterization and Electrochemical Properties of Li<sub>2</sub>Cu<sub>0.5</sub>Ni<sub>0.4</sub>M<sub>0.1</sub>O<sub>2</sub> Lithium-ion Battery Cathodes," in Rechargeable Lithium and Lithium Ion Batteries, ECS Transactions, 16 (29), 27-35 (2009).
14. **C.T. Love**, K.E. Swider-Lyons, A. Korovina, D.E. Ramaker and W. Dmowski, "Instability of Cathode Materials in Li-ion Batteries: Oxygen Loss and SEI Formation," Proceedings of the 44<sup>th</sup> Power Sources Conference, Las Vegas, NV (2010).

15. **C.T. Love**, M.D. Johannes and K.E. Swider-Lyons, "Thermal Stability of Delithiated Al-substituted  $\text{Li}(\text{Ni}_{1/3}\text{Co}_{1/3}\text{Mn}_{1/3})\text{O}_2$  Cathodes," in *Rechargeable Lithium and Lithium Ion Batteries*, ECS Transactions, 25 (36), 231-240 (2010).
16. C.P. Patridge, **C.T. Love**, "Impedance Spectroscopy Diagnostic for Monitoring Individual LIB Overcharge," Proceedings of the 45<sup>th</sup> Power Sources Conference, Las Vegas, NV (2012).
17. **C.T. Love**, M.E. Twigg, "Originations of Impedance in Silicon Anode Materials," Proceedings of the 45<sup>th</sup> Power Sources Conference, Las Vegas, NV (2012).
18. O. Baturina, **C.T. Love** and K.E. Swider-Lyons, "*In-situ* Optical Visualization of Li Dendrite Growth at Sub-ambient Temperatures," Proceedings of the 46<sup>th</sup> Power Sources Conference, Orlando, FL (2014).
19. K.E. Swider-Lyons, **C.T. Love**, C.J. Patridge, D.E. Ramaker and W. Dmowski, "Structure-Stability Correlations in Li-Ion Battery Cathode Materials," MRS Online Proceedings Library, 1655 (2014).

### Book Chapters

1. "Processing of Carbon Nanotube-Based Nanocomposites," V.M. Karbhari and **C.T. Love**, in *Advances in Polymer Processing: macro- to nano-scales*, Editors: Sabu Thomas and Yang Weimin, Woodhead Publishing Ltd., Cambridge, UK, 2009, ISBN 978-1-84569-396-1.
2. "Processing of Carbon Nanotube-Based Nanocomposites," V.M. Karbhari and **C.T. Love**, in *Advances in Polymer Nanocomposites: types and applications*, Editor: Fengge Gao, Woodhead Publishing Ltd., Cambridge, UK, 2012, ISBN 978-1-84569-940-6.
3. "Density Functional Theory Calculations in Li-ion Battery Materials Research," M.D. Johannes, **C.T. Love** and K.E. Swider-Lyons, in *Handbook of Electrochemistry*, Springer, *in press*.

### Technical Reports

1. **C.T. Love** and A. Gaskins, "Performance Loss in Lithium Ion Polymer Batteries Subjected to Overcharge and Overdischarge Abuse," NRL Memorandum Report, November 16, 2012.
2. C.P. Patridge and **C.T. Love**, "Impedance Spectroscopy Diagnostic for Li-ion Battery Monitoring," NRL Memorandum Report, March 12, 2013.

### TECHNICAL PRESENTATIONS (Invited Only)

1. "Navy Lithium Battery Technology Development," **C.T. Love**, K.E. Swider-Lyons and S. Rose-Pehrsson, *Lithium Way Ahead Battery Summit*, NSWC CRANE, IN, March 3-4, 2010.
2. "Navy Lithium Battery Technology Development: NRL," **C.T. Love**, *Lithium Battery Summit II*, NSWC Carderock, MD, April 29-30, 2011.
3. "Diagnostic Tools Development for Understanding and Monitoring Overcharged Li-ion Batteries," **C.T. Love**, A. Korovina, D. Ramaker and K.E. Swider-Lyons, *12<sup>th</sup> Electrochemical Power Sources R&D Symposium*, Monterey, CA, June 20-23, 2011.
4. "Lithium Intercalation in Nanoscale Electrode Materials: Silicon Nanostructures," **C.T. Love**, *Lithium Power 2011*, Las Vegas, NV, November 8, 2011.

5. "Diagnostic Tools Development for Understanding and Monitoring Overcharge," **C.T. Love**, *Battery Safety 2011*, Las Vegas, NV, November 10, 2011.
6. "Diagnostic Tools for Lithium-Ion Battery State-of-Health Monitoring," **C.T. Love**, K.E. Swider-Lyons and M.D. Johannes, *Joint Services & OSD Africa Technical Exchange*, May 27, 2014.  
Brief available online:  
<https://community.apan.org/afosr/w/researchareas/123333.joint-services-osd-africa-technical-exchange.aspx>
7. "Chemical and Electrochemical Indicators of Battery State-of-Health," **C.T. Love**, O. Baturina and K.E. Swider-Lyons, *U.S. National Congress on Theoretical and Applied Mechanics*, East Lansing, MI, June 17, 2014.
8. "Diagnostic Tools for Lithium-ion Battery State-of-Health Monitoring," **C.T. Love**, O. Baturina, K.E. Swider-Lyons and M.D. Johannes, *AFOSR/NIH/CNR Technical Exchange Meeting with Italian Research Council*, August 24, 2014.

### PATENTS (Pending)

1. "Battery Health Monitoring System and Method," C.T. Love and K.E. Swider-Lyons, WO Patent 2,013,085,996.
2. "Battery Health Monitoring System and Method," C.T. Love and K.E. Swider-Lyons, US Patent 20,130,141,109.

### VOLUNTEER AND LEADERSHIP ACTIVITIES

- Session Chair, U.S. National Congress on Theoretical and Applied Mechanics 2014
- Vice-President, Fairlington Glen Condominium Board of Directors 2014 – Present
- Landscape Committee Chair, Fairlington Glen Condominium 2012 – Present
- Session Chair, Meeting of the Electrochemical Society 2012
- Elementary School Tutor, Patterson Elementary School 2010 – Present
- Science Fair Judge (Montgomery Co., D.C., Hayfield Elementary) 2010 – Present
- Mentor, HBCU & Minority Institution Student Intern Program 2009 – Present
- Audience Correspondent, Greenovation Forum, UCSD 2007
- Session Chair, Meeting of the American Chemical Society 2006

### PROFESSIONAL SOCIETY MEMBERSHIPS

- American Society of Naval Engineers (ASNE) 2011 – Present
- Electrochemical Society (ECS) 2008 – Present

### PROFESSIONAL AND TECHNICAL DEVELOPMENT

- Excelling as a Manager or Supervisor, 8.0 hours
- Leadership Skills for Scientists and Engineers, 8.0 hours
- Future Naval Capabilities (FNC) Training, 4.0 hours
- How to Advance in your Federal Career, 1.5 hours
- Advanced Impedance Spectroscopy, Electrochemical Society Short Course, 8.0 hours
- Introduction to Electronic Ship Power, ASNE Short Course, 4.0 hours
- Introduction to Autonomous Systems, ASNE Short Course, 4.0 hours