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RPPR Final Report
as of 12-Aug-2017

Agency Code:

Proposal Number: 70788CHCF **Agreement Number: W911NF-17-1-0117**
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Report Date: 14-Nov-2017 Date Received: 11-Aug-2017
Final Report for Period Beginning 15-Feb-2017 and Ending 14-Aug-2017
Title: Symposium ES13 - Interfaces and Interphases in Electrochemical Energy Storage and Conversion
Begin Performance Period: 15-Feb-2017 **End Performance Period:** 14-Aug-2017
Report Term: 0-Other

Submitted By: Donna Gillespie Email: gillespie@mrs.org
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STEM Degrees: 0 **STEM Participants:** 4

Major Goals: This symposium brought together materials scientists, chemists, physicists, theorists, and engineers to discuss the status and future perspectives, including existing and upcoming challenges and opportunities, in the field of electrolytes for electrochemical energy storage and to create new ideas and collaborations to address those challenges. The goal was to promote scientific exchange and to advance science discovery and engineering innovation.

ARO funds supported invited speakers from academia, many of whom have limited funds available for travel to conferences to present their scientific research and to network with experts in their field. Funds also supported student presenters.

Accomplishments: Symposium ES13 was held at the 2017 MRS Spring Meeting and provided an international forum for scientists and engineers from academia, national labs, and industry to discuss frontier research related to interfaces and interphases in electrochemical energy storage and conversion that includes batteries, supercapacitors, and fuel cells. The symposium also presented the three-section tutorial on “Electrolytes for Electrochemical Energy Storage—Materials, Interfaces and Interphases” by three distinguished scientists in the field for graduate students and early career scientists. The symposium featured 110 presentations, including 76 oral presentations (of which 21 were invited speakers from across the world) and 34 poster presentations. The five-day event saw a large crowd throughout the program with peak attendance well above 140 people. Two presenters were nominated for prestigious MRS Graduate Student Awards (GSA) by the symposium and both won the Gold Award that recognizes students of exceptional ability who show promise for significant future achievement in materials research. The symposium organizers presented three Graduate Student travel grants and one Best Oral Presentation travel grant.

Training Opportunities: The student presenters were exposed to the professional world of materials science and allowed them to learn how their research contributes to this discipline.
It also provided a forum for the students to communicate effectively with diverse audiences. Dialogues with the scientific community require a range of skills that are not often part of the traditional materials science pedagogy.

RPPR Final Report
as of 12-Aug-2017

Results Dissemination: The program is posted to the MRS website: www.mrs.org
MRS members will have access to MRS Advances, a new peer-reviewed online-only journal featuring impactful research, in particular, rapid reports of work in progress from MRS. The journal covers new and emerging science and is designed to reflect the way materials researchers work, write, publish and share their results. Article scope offers a focused, in-depth look at key materials topics of current interest.

Honors and Awards: Nothing to Report

Protocol Activity Status:

Technology Transfer: Nothing to Report

Report to Army Research Office (ARO)

MRS 2017 Spring Meeting, Phoenix, AZ, April 17 - April 21, 2017

Symposium ES13: Interfaces and Interphases in Electrochemical Energy Storage and Conversion

Symposium Organizers:

Yuyan Shao, Pacific Northwest National Laboratory
Lynn Trahey, Argonne National Laboratory
Jin Suntivich, Cornell University
David Mitlin, Clarkson University

Summary:

Symposium ES13 was held at the 2017 MRS Spring Meeting and provided an international forum for scientists and engineers from academia, national labs, and industry to discuss frontier research related to interfaces and interphases in electrochemical energy storage and conversion that includes batteries, supercapacitors, and fuel cells. The symposium also presented the three-section tutorial on "Electrolytes for Electrochemical Energy Storage—Materials, Interfaces and Interphases" by three distinguished scientists in the field for graduate students and early career scientists. The symposium featured 110 presentations, including 76 oral presentations (of which 21 were invited speakers from across the world) and 34 poster presentations. The five-day event saw a large crowd throughout the program with peak attendance well above 140 people. Two presenters were nominated for prestigious MRS Graduate Student Awards (GSA) by the symposium and both won the Gold Award that recognizes students of exceptional ability who show promise for significant future achievement in materials research. The symposium organizers presented three Graduate Student travel grants and one Best Oral Presentation travel grant.

Objectives:

Interfaces and interphases are at the heart of the electrochemical reactions. Manipulating interfaces and interphases so that the electrochemical reactions and processes take place in a controlled and desired way can have a profound impact on the performance of the electrochemical energy storage and conversion devices. However, this is a grand challenge as interfaces and interphases are usually thermodynamically unstable in electrochemical energy storage and conversion devices. Materials innovation, in-depth fundamental understanding through advanced characterization and simulation, and device/system integration are all needed to make all parts work perfectly together.

This symposium aims to bring together materials scientists, chemists, physicists, theorists, and engineers to discuss the status and future perspectives, including existing and upcoming challenges and opportunities in this field and to create new ideas and collaborations to address those challenges.

Research highlights:

The symposium presentations were divided into the following topic areas plus a three-section tutorial:

1. Electrocatalysts and Battery Interfaces
2. Battery Anodes and Interfaces
3. Electrocatalysis
4. Solid-State and Concentrated Electrolytes
5. Li-S/Li-O2 Batteries
6. Li-Ion Batteries—Cathode
7. Li-Ion Batteries—Anodes
8. Interfaces/Interphases—Characterization/Simulation
9. High Temperature Electrochemistry

In the Tutorial, Kang Xu (U. S. Army Research Laboratory-ARL) taught basic electrochemistry, liquid electrolytes and electrode/electrolyte interfaces/interphases; Nancy Dudney (Oak Ridge National Lab-ORNL) taught glass solid-state electrolytes and their interfaces/interphases; Chunsheng Wang (University of Maryland) taught ceramic oxide crystalline electrolytes. Attendees had very good interaction with the instructors in the Question/Answer sections.

In Topic Area (1), Gianluigi Botton (McMaster University, Canada) discussed in-situ TEM characterization of battery and fuel cell materials and interfaces; Yang Shao-Horn (MIT) and her collaborator discussed experimental and modeling study on Li-ion battery electrode-electrolyte interface with a focus on cathodes, including fading mechanisms, electrolyte/electrode interaction. Fudong Han (University of Maryland), the MRS GSA Gold Awardee, discussed solid electrolyte and cathode interfaces, who revealed a long-term hidden misunderstanding about solid electrolyte stability.

In Topic Area (2), Reza Shahbazian-Yassar (University of Illinois at Chicago) discussed nanoscale ionic transport in battery materials and interphases. David Mitlin (Clarkson University) discussed how Li+ activation of electrode materials can promote Na+ storage. Juhye Song (Hanyang University, Korea) discussed molten salt electrolyte for Na metal batteries. Clement Bommier (Oregon State University) discussed new solid/electrolyte interphase (SEI) formation mechanism for Na+ ion batteries, which was found to be crucial for long-term cycling of batteries.

In Topic Area (3), Thomas J. Schmidt (Paul Scherrer Institute, Switzerland) discussed oxygen evolution reaction on nano-scaled perovskites and presented how lattice oxygen, oxygen mobility and surface/bulk structure affected electrochemical reactions. Jin Suntivich (Cornell University) discussed his model system study on electrocatalysis using single-crystal transition-metal oxides, including surface chemistry and surface reactions. Sanjeev Mukerjee (Northeastern University) discussed his new discovery of hydrogen reaction mechanisms in alkaline

electrolyte, answered a long-term debated question about hydrogen adsorption, OH- activation and their synergy.

In Topic Area (4), Nancy J. Dudney (ORNL) discussed lithium metal/solid state electrolyte interphases, highlighted the importance of connecting theoretical modeling with experimental research, also highlighted the interface engineering of thermodynamically unstable system into kinetically stable system, pointed out the importance of advanced tools to understand interface/interphase phenomena. Jennifer L. Rupp (MIT) discussed interface engineering of solid-state electrolytes/electrode not only for battery but also for sensing applications. Kang Xu (ARL) discussed concentrated aqueous electrolytes and related interfaces, highlighted SEI and water chemistry change under this new chemistry regime. Not only Li/graphite, but also Li metal can work in the concentrated aqueous electrolytes – an electrochemical process that was considered impossible before. C. Austen Angell (Arizona State University) gave an overview of ultra-concentrated electrolytes and multivalent energy storage.

In Topic Area (5), Jun Lu and collaborator (Argonne National Laboratory – ANL) discussed their recent study on anion-redox cathodes, highlighted the closed Li-O system which presents greater promise than open systems. Wu Xu (Pacific Northwest National Lab-PNNL) discussed in situ formed SEI in Li-O2 batteries. Yi Cui (Stanford University) discussed new progress on Li-S batteries in his group, highlighted various interfaces in this battery system including Li metal/electrolyte, S/carbon, S-carbon/electrolyte, polymer/ceramics. Kevin R. Zavadil (Sandia National Labs-SNL) discussed Li metal protection in Li-S batteries.

In Topic Area (6), Xiqian Yu (Institute of Physics, Chinese Academy of Sciences) discussed in-depth understanding of Li battery cathodes and interfaces/interphases using synchrotron-based characterization. Jaephil Cho (Ulsan National Institute of Science and Technology, Korea) discussed cathode/electrolyte interfaces/interphase, highlighted the importance of uniform cathode materials, pointed out the future research direction of long-term stable cathodes. Y. Shirley Meng (University of California, San Diego) discussed the integration of advanced tools in characterizing battery materials.

In Topic Area (7), Chongmin Wang (PNNL) and his collaborator discussed recent in-situ TEM characterization of battery materials. Yingge Du (PNNL) discussed fundamental understanding of Li+ intercalation/conversion reaction with metal oxides using model systems. Jun Wang (A123 Systems) gave an industrial perspective on Li battery electrode development. Jokin Rikarte (CIC-energiGUNE, Spain) discussed interface structure/chemistry evolution of battery electrode materials during cycling.

In Topic Area (8), Ethan J. Crumlin (Lawrence Berkeley National Laboratory-LBL) discussed ambient pressure XPS study of solid electrode/liquid electrolyte interfaces, presented a smart design of electrochemical cell for this kind of research, highlighted surface chemistry evolution with electrochemical stressing. Andreas Magerl (University of Erlangen-Nurnberg, Germany) presented new understanding of the solid–ionic liquid interface structure using a complementary X-Ray reflectivity and molecular dynamics approach. Nathan D. Kirchhofer (Asylum Research)

discussed localized SPM electrochemistry. David Prendergast (LBL) presented new understanding of Mg metal electrode surface electrochemistry and its relationship with electrolytes, highlighted a similar SEI concept as that in Li and Na battery systems. Kevin Leung (SNL) provided a unique perspective of understanding Li dendrite formation using grain boundary concept in solid-state electrolytes, pointed out to the importance of the uniformity of SEI in terms of both structure and chemistry.

In Topic Area (9), Dongkyu Lee (ORNL) discussed the influence of strain on oxygen electrocatalysis in perovskite thin films. Gary K. Ong (University of Texas at Austin) discussed scalable solution chemistry synthesis of colloidal nanocrystals and its film formation, highlighted the proton transport property and its relationship to film structures. Aoife K. Lucid (Trinity College Dublin, Ireland) discussed the interface engineering in solid oxide fuel cells and its influence on performance. Qiyang Lu (MIT), who is also MRS GSA Gold Awardee, discussed electrochemically driven phase transition of functional metal oxides, including crystal structure evolution and electronic structure evolution, highlighted in situ probing of these properties. Erik D. Spoerke (SNL) discussed intermediate temperature Na batteries for grid application, emphasized different applications for different battery chemistries.

Contributions to the Discipline:

This symposium (ES13) brought together an interdisciplinary group of scientists and engineers from all over the world, including materials scientists, chemists, physicists, theorists to understand, design and engineer materials and interfaces/interphase for advanced electrochemical energy storage and conversion devices. The symposium helped them to address existing challenges and identify new challenges on the road, promote collaboration, generate new ideas and identify future applications. The symposium offered a forum where experimentalists found their theorist peers for first principle understanding and the theorists found their experimentalist peer to test their hypothesis. The symposium offered a forum for scientists to cross their disciplinary board, find new field, create new ideas. The organizers believe that the ideas and collaborations fostered by the symposium ES13 will drive the successful in-depth understanding of science questions, smart design of new materials for applications in the electrochemical energy storage and conversion space, and bring the field to a new high level.

In terms of funding management, Symposium ES13 organizers used the ARO grant to pay for the registration fees for selected invited speakers (and organizers) who were carefully selected based on the two criteria: (1) innovation and importance of the work and (2) attendance of the talks. A portion of the funds was also used to provide three Symposium Graduate Student travel grants and one Best Oral Presentation travel grant.

Graduate Student Travel Grants

Xiaohong Xie
Jan Kloppenburg
Jie Zhao

Best Oral Presentation Travel Grant
Wu Xu

Invited Speakers
Gianluigi Boton
Reza Shahbazian-Yassar
Thomas Schmidt
Sanjeev Mukerjee
Xiqian Yu
Jaephil Cho
Chunshen Wang
Y. Shirley Meng
Jun Wang

Future Directions:

Energy sustainability, security and affordability remain a critical issue of our society, for which electrochemical energy storage and conversion will play an important role. MRS has long recognized this fact and embraced the challenge in every meeting, and this trend is expected to continue at a higher level of momentum in the foreseeable future. The integration of advanced experimental and theoretical tools is expected to promote research efforts in this field. Further conference symposia of this theme will serve to accelerate our efforts.

Acknowledgements:

The organizers gratefully appreciate the support from the US Army Research Office (ARO), which was critical to the success of this symposium. We also want to thank MRS staff for supporting the application of this ARO grant.

SYMPOSIUM ES13

Interfaces and Interphases in Electrochemical Energy Storage and Conversion
April 17 - April 21, 2017

Symposium Organizers
David Mitlin, Clarkson University
Yuyan Shao, Pacific Northwest National Laboratory
Jin Suntivich, Cornell University
Lynn Trahey, Argonne National Laboratory

Symposium Support
Army Research Office

Proceedings Statement
All authors are invited to submit articles based on their 2017 MRS Spring Meeting presentations to the journals in the MRS portfolio (www.mrs.org/publications-news). Papers submitted and accepted for publication in MRS Advances (www.mrs.org/mrs-advances) will be available as symposium collections. Visit the MRS/Cambridge University Press Publications Booth #100 in the Exhibit Hall to learn more, including MRS Advances print options available at special rates during the meeting week only.

* Invited Paper

TUTORIAL
Electrolytes for Electrochemical Energy Storage—Materials, Interfaces and Interphases

Monday Morning, April 17, 2017
8:30 AM – 12:00 PM
PCC North, 200 Level, Room 227 AB

Batteries are critical for today's society and are also hot topic in material research community. Electrolytes and the electrode/electrolyte interfaces/interphase play a determining role in batteries—a thermodynamically unstable but kinetically stable system enabled by electrolytes and the interfaces/interphases.

This tutorial will cover from fundamental interfacial electrochemistry, electrolyte materials, to electrode/electrolyte interfaces/interphases related to electrochemical energy storage. It will bring attendees both the fundamental knowledge and updates in this rapidly evolving field. The tutorial consists of three sections:

8:30 AM - 9:30 AM
Part I: **Kang Xu**
Electrode/Liquid Electrolyte Interfaces and Interphases

The basic concepts of electrochemical interfaces and interphases in liquid electrolytes will be covered, including a general overview of electrochemistry concepts in both nonaqueous solutions and aqueous solutions, solid/electrolyte interphases (SEI), dynamic evolution of interfaces and interphases and its characterization. Application examples may include SEI on metal anodes, graphite, silicon, sulfur cathodes, selected metal oxide cathodes. This part provides the knowledge foundation of the whole tutorial.

9:30 AM BREAK

10:00 AM - 11:00 AM
Part II: **Nancy J. Dudney**
Glass Solid State Electrolytes (GSSE) and their Interfaces/Interphases

Moving beyond electrode/liquid electrolyte systems, the electrode/GSSE is one of the enablers of solid state batteries. Topics include the basic concept of GSSE, GSSE materials and their properties, ion transport mechanisms, electrode/GSSE interfaces and interphases, and the difference (advantages/disadvantages) between electrode/liquid electrolyte systems and electrode/GSSE systems.

11:00 AM - 12:00 PM
Part III: **Chunsheng Wang**
Ceramic Oxide Crystalline Electrolytes and their Interfaces/Interphases

Great challenges exist for the application of ceramic oxide crystalline electrolytes in batteries, but they also present broader advantages that the above liquid electrolyte and GSSE do not have. In this section, the basic concept of ceramic oxide crystalline electrolytes, ion transport mechanisms, electrolytes materials and interface/interphase engineering will be covered. It also contains a sub-section to compare the three electrolytes (liquid, GSSE, ceramic oxide crystalline electrolytes), their interfaces/interphases and battery device engineering using these three electrolytes.

Instructors
Kang Xu, U.S. Army Research Laboratory
Nancy Dudney, Oak Ridge National Laboratory
Chunsheng Wang, University of Maryland, College Park

SESSION ES13.1: Electrocatalysts and Battery Interfaces
Session Chairs: Yuyan Shao and Jin Suntivich
Monday Afternoon, April 17, 2017
PCC North, 200 Level, Room 227 AB

1:30 PM *ES13.1.01
Analytical Microscopy of Complex Alloy Catalysts, Hybrid Supports and Battery Materials Gianluigi A. Botton; McMaster University, Canada.

2:00 PM ES13.1.02
Revealing the Structure Evolutions of the Ni-Co-OH OER Electrocatalyst by *In Situ* Liquid Cell XANES Kaiyang Niu[1,2]; [1]Lawrence Berkeley National Laboratory, United States; [2]University of California, Berkeley, United States.

2:15 PM ES13.1.03
Facile Synthesis of Nanostructured Phosphide Electrocatalysts Nicola Pinna; Humboldt-Universität Berlin, Germany.

2:30 PM ES13.1.04
Facile Synthesis of Colloidal β-FeOOH Nanorod Catalysts Doped with Transition Metals for Efficient Water Oxidation Tomiko M. Suzuki; Toyota Central R&D Labs Inc, Japan.

2:45 PM ES13.1.05
Magnetic-Structure Determined Concentration and Mobility of the Oxygen Vacancy in $LaBO_3$ (B=Cr, Mn, Fe, Co) Perovskite Materials of Solid Oxide Fuel Cell Cathode Lei Zhang; Georgia Institute of Technology, United States.

3:00 PM BREAK

3:30 PM *ES13.1.06
Electrode-Electrolyte Interface at Positive Electrodes in Li-Ion Batteries—Mechanisms of Formation, Chemical Composition and Implications for Battery Performance Yang Shao-Horn; Massachusetts Institute of Technology, United States.

4:00 PM ES13.1.07
Cathode/Electrolyte Interface—Revisiting the Electrochemical Stability of Solid Electrolytes Fudong Han; University of Maryland College Park, United States.

4:15 PM ES13.1.08
Electrolyte and Interface Optimization for High Voltage Phospho-Olivine Based Li-Ion Batteries Jan Allen; U.S. Army Research Lab, United States.

4:30 PM ES13.1.09
Evaluation of Tris(2,2,2-trifluoroethyl) Phosphite (TTFP) Additive as a Cathode Electrolyte Interphase (CEI) Forming Agent Ritu Sahore; Argonne National Laboratory, United States.

4:45 PM ES13.1.10
Sulfide Solid Electrolytes—Long-Range and Local Li-Ion Dynamics in the Glass-Ceramic Li_3PS_4 Denise Prutsch; Graz University of Technology, CD-Laboratory for Lithium Batteries, Austria.

SESSION ES13.2: Battery Anodes and Interfaces
Session Chairs: David Mitlin and Yuyan Shao
Tuesday Morning, April 18, 2017
PCC North, 200 Level, Room 227 AB

10:30 AM *ES13.2.01
Observation of Ionic Transport and Electrochemistry at Nanoscale Reza Shahbazian-Yassar; University of Illinois at Chicago, United States.

11:00 AM ES13.2.02
Activation with Li Enables Facile Sodium Storage in Germanium David Mitlin; Clarkson University, Canada.

11:15 AM ES13.2.03
Dendrite-Free Sodium Metal Interface in Highly Concentrated Na^+-Conductive Inorganic Electrolyte Juhye Song; Hanyang University, Korea (the Republic of).

11:30 AM ES13.2.04
New Insights on SEI Formation and Its Effects on Long-Term Cycling Life of Na/C Batteries Clement Bommier; Oregon State University, United States.

11:45 AM ES13.2.05
Anode Surface Evolution in Aqueous Sodium-Ion Batteries Xiaowen Zhan; University of Kentucky, United States.

SESSION ES13.3: Electrocatalysis
Session Chairs: David Mitlin and Jin Suntivich
Tuesday Afternoon, April 18, 2017
PCC North, 200 Level, Room 227 AB

1:30 PM *ES13.3.01
The Oxygen Evolution Reaction on Nano-Scaled Perovskites Thomas J. Schmidt[1, 2]; [1]Paul Scherrer Institute, Switzerland; [2]ETH Zurich, Switzerland.

2:00 PM ES13.3.02
Electrocatalysis on Epitaxially Grown, Single-Crystal Transition-Metal Oxides Jin Suntivich; Cornell University, United States.

2:15 PM ES13.3.03
Adsorbates Energy during Oxygen Evolution Reaction—A Theory-Experiment Comparison Jan Kloppenburg; UCLouvain, Belgium.

2:30 PM BREAK

3:00 PM *ES13.3.04
Electrocatalytic Challenges in High pH Environment Sanjeev Mukerjee; Northeastern University, United States.

3:30 PM ES13.3.05
Bifunctional CoP and Co-Ni-P Nanowire Electrocatalysts for Efficient and Ultrastable Electrochemical Water Splitting Lifeng Liu; International Iberian Nanotechnology Laboratory, Portugal.

3:45 PM ES13.3.06
Unified View of Cation Segregation, Precipitation and Surface Reconstruction in $(La,Sr)FeO_{3-\delta}$ Michael L. Machala; Stanford University, United States.

4:00 PM ES13.3.07
Ultrasensitive Probing of the Local Electronic Structure of Nitrogen Doped Carbon and Its Applications to 2D Electronics, Catalysis and Bio-Physics Charles J. Titus; Stanford University, United States.

4:15 PM ES13.3.08
Core/Shell Interface and Surface Nanophase Structure-Controlled Functionality of Metallic Catalysts by Resonant High-Energy X-Ray Diffraction Valeri Petkov; Central Michigan University, United States.

4:30 PM ES13.3.09
Gold Micromeshes as Highly Active Electrocatalysts for Methanol Oxidation Reaction Jingying Sun; University of Houston, United States.

4:45 PM ES13.3.10
Rational Design of Solid Electrode Interface for Highly Reversible Lithium-Metal Battery Snehashis Choudhury; Cornell University, United States.

SESSION ES13.4: Solid-State and Concentrated Electrolytes
Session Chairs: David Mitlin and Jin Suntivich
Wednesday Morning, April 19, 2017
PCC North, 200 Level, Room 227 AB

8:15 AM *ES13.4.01
Evolution of the Lithium Metal/Solid Electrolyte Interface Nancy J. Dudney; Oak Ridge National Laboratory, United States.

8:45 AM ES13.4.02
Engineering Interfaces and Performances for All Solid State Li-Battery Architectures and Novel Types of CO_2 Sensing Devices Based on Li-Garnet Electrolytes Jennifer L. Rupp; Massachusetts Institute of Technology, United States.

9:00 AM ES13.4.03
Atomic Layer Deposition of Conformal Solid State Batteries Alexander Pearse; University of Maryland, College Park, United States.

9:15 AM ES13.4.04
Na_2S Based Glassy Electrolytes for Solid State Sodium Ion Batteries—A Modeling-Based Study Soumik Banerjee; Washington State University, United States.

9:30 AM ES13.4.05
Design of Stable Non-Oxide Sodium Superionic Conductor Amitava Choudhury; Missouri University of Science and Technology, United States.

9:45 AM BREAK

10:15 AM *ES13.4.06
Forming Interphase in Aqueous Media Kang Xu; U.S. Army Research Laboratory, United States.

10:45 AM *ES13.4.07
Ultraconcentrated "Solutions" for Alkali Metal and Multivalent Energy Storage Electrolytes—Common Features and Ionicities C. Austen Angell; Arizona State University, United States.

11:15 AM ES13.4.08
Asymmetric Microsupercapacitors with Vertically Scaled 3D Porous Current Collectors Husam N. Alshareef; King Abdullah University of Science and Technology (KAUST), Saudi Arabia.

11:30 AM ES13.4.09
In Operando SEM of Plating in All-Solid-State Lithium-Ion Battery with Carbon Anodes Alexander Yulaev[1, 2, 3]; [1]National Institute of Standards and Technology, United States; [2]University of Maryland, United States; [3]University of Maryland, United States.

11:45 AM ES13.4.10
On the Interface and Role of Interlayers between High Voltage Cathode LMNO and Solid State Electrolyte LLZO Alejandro N. Filippin; Empa, Switzerland.

SESSION ES13.5: Li-S/Li-O2 Batteries
Session Chairs: Yuyan Shao and Wu Xu
Wednesday Afternoon, April 19, 2017
PCC North, 200 Level, Room 227 AB

1:30 PM *ES13.5.01
Anion-Redox Solid Nanolithia Cathode for Li-Ion Battery Jun Lu; Argonne National Laboratory, United States.

2:00 PM ES13.5.02
Real Time Study of a Working Li-Oxygen Battery Using *In Situ* TEM in Organic-Based Liquid Electrolyte Kun He; University of Illinois at Chicago, United States.

2:15 PM ES13.5.03
Enhanced Cycling Stability of Lithium-Oxygen Batteries through *In Situ* Formed Electrode Interface Layers Wu Xu; Pacific Northwest National Lab, United States.

2:30 PM BREAK

3:30 PM *ES13.5.04
Lithium Sulfur Batteries—Fundamental Understanding and Materials Design Yi Cui; Stanford University, United States.

4:00 PM *ES13.5.05
Protected Lithium Anodes for Enhanced Cycle Life of Lithium – Sulfur Batteries Kevin R. Zavadil; Sandia National Labs, United States.

4:30 PM ES13.5.06
Chemical Routes for the Formation of Solid Electrolyte Interphase Layers on Sulfur Cathodes in Li-S/Na-S Batteries Luning Wang; University of Maryl, College Park, United States.

SESSION ES13.6: Li-Ion Batteries—Cathode
Session Chairs: David Mitlin and Lynn Trahey
Thursday Morning, April 20, 2017
PCC North, 200 Level, Room 227 AB

8:15 AM *ES13.6.01
Structural Stability of Layered Oxide Cathode Materials for High Energy Density Lithium Ion Batteries Xiqian Yu; Institute of Physics, Chinese Academy of Sciences, China.

8:45 AM *ES13.6.02
Deterioration of Interfaces/Interphases in Lithium Ion Battery Cathodes and Their Solutions Jaephil Cho; Ulsan National Institute of Science and Technology, Korea (the Republic of).

9:15 AM ES13.6.03
Surface Nano-Coating as a Novel Approach to Improve the Structural Stability of Layered Oxide Cathodes in Li-Ion Batteries Soroosh Sharifi-Asl; UIC, United States.

9:30 AM BREAK

10:00 AM *ES13.6.04
Advanced Diagnosis Tools for Probing Interfaces and Surfaces in Electrochemical Systems Y. Shirley Meng; University of California, San Diego, United States.

10:30 AM *ES13.6.05
Meso and Micron Scale Chemical and Morphological Heterogeneities in High Energy Density Lithium-Ion Electrodes Jagjit Nanda; Oak Ridge National Laboratory, United States.

11:00 AM *ES13.6.06
Insight into Microstructural Evolution in Lithium-Based Batteries by Electron Microscopy Dean J. Miller; Argonne National Laboratory, United States.

11:30 AM ES13.6.07
Depth and Width of Interfaces—Assessment Soft X-Ray Electronic Structure of Battery Electrodes Operando with Hard X-Rays Artur Braun; EMPA, Switzerland.

11:45 AM ES13.6.08
The Dissociation of Dimethyl Carbonate (DMC) on Layered Oxide $LiCoO_2$(110)—A First–Principles Study Jun Li; NIMTE, China.

SESSION ES13.7: Li-Ion Batteries—Anodes
Session Chairs: Yingge Du and Jun Wang
Thursday Afternoon, April 20, 2017
PCC North, 200 Level, Room 227 AB

1:30 PM *ES13.7.01
Advanced Electron Microscopy Probing of Functioning Mechanisms of Nanoscale Surface Coating Layer for Mitigating Capacity Fading of Lithium Ion Battery Chongmin N. Wang; Pacific Northwest National Lab, United States.

2:00 PM ES13.7.02
Li Ion Intercalation and Conversion Reactions in WO3 Thin Film Electrodes Studied by *In Situ* TEM Yingge Du; Pacific Northwest National Lab, United States.

2:15 PM ES13.7.03
Artificial Solid Electrolyte Interphase-Protected Li_xSi Nanoparticles—An Efficient and Stable Prelithiation Reagent for Lithium-Ion Batteries Jie Zhao; Stanford University, United States.

2:30 PM ES13.7.04
***In Situ* Electrochemical Atomic Force Microscopy of the Solid Electrolyte Interphase Formed on HOPG in Superconcentrated Electrolyte** Ngoc Duc Trinh[1, 2, 3]; [1]Universite de Montreal, Canada; [2]Regroupement Québécois pour les matériaux de pointe, Canada; [3]Centre Québécois sur les matériaux fonctionnels, Canada.

2:45 PM BREAK

3:15 PM *ES13.7.05
Designing Silicon Based High Energy Cells through Active Materials Surface Modification and Process Optimization Jun Wang; A123 Systems, LLC, United States.

3:45 PM ES13.7.06
Elucidating $Li_4Ti_5O_{12}$ (111) Surface Evolution upon Electrochemical Cycling Jokin Rikarte; CIC-energiGUNE, Spain.

4:00 PM ES13.7.07
First-Principles Study of the Reduction Mechanisms of Ethylene Carbonate on the Amorphous Lithiated Surfaces of Silicon Anodes in Lithium-Ion Battery Chin-Lung Kuo; National Taiwan University, Taiwan.

4:15 PM ES13.7.08
Multi-Graft Copolymer Polymer Binder for Silicon Anode Tomonori Saito; Oak Ridge National Laboratory, United States.

4:30 PM ES13.7.09
Suppression of Lithium Dendrites using Graphene Oxide Tara Foroozan; University of Illinois at Chicago, United States.

4:45 PM ES13.7.10
Conditioning of Na^+ Conductivity in a Glass Electrolyte by Dipole - Dipole Interactions, "Role of Electric Dipoles in a Na^+ Glass Electrolyte" Andrew Murchison; University of Texas Austin, United States.

SESSION ES13.8: Poster Session
Session Chairs: David Mitlin, Yuyan Shao, Jin Suntivich and Lynn Trahey
Thursday Afternoon, April 20, 2017
8:00 PM - 10:00 PM
Sheraton, Third Level, Phoenix Ballroom

ES13.8.01
Amorphous Molybdenum Disulfide as a Hydrogen Evolution Reaction Catalyst for Photoelectrochemical Water Splitting Ahmad M. Fallatah; Iowa State University, United States.

ES13.8.02
Computational Insights to Charge Transfer Reactions at Electrode/SEI/Electrolyte Interface Yunsong Li; Michigan State University, United States.

ES13.8.03
Electrochemical Impedance Spectroscopy Investigation of Solid-Electrolyte Interphase Formation in Lithium-Ion Battery Anodes Yige Li; University of California, Riverside, United States.

ES13.8.04
Tungsten Disulfide as a Photocatalyst for Efficient Solar Water Splitting Tian Lan; Iowa State University, United States.

ES13.8.05
Metal-Organic Frameworks Derived Metal Embedded Carbons Materials as Catalysts for Efficient Electrocatalysis Yan Liang; Monash University, Australia.

ES13.8.06
Co and N Co-Doped Carbon Nanotubes for Efficient Oxygen Reduction Reaction Electrocatalyst Yinggang Zhu; South University of Science and Technology of China, China.

ES13.8.07
Controllable Synthesis of Inorganic Electrocatalysts for Energy Conversion Related Reactions Yong Zhao; Henan University, China.

ES13.8.08
The Effect of Electrochemical Modification of the Glass Carbon Surface in Conditions of Chemisorption of Fluorine-Containing Nanogroups on Its Electrophysical Properties Sergey M. Karabanov; Ryazan State Radioengineering University, Russian Federation.

ES13.8.09
Designing Bifunctional Catalyst for Oxygen Reduction/Evolution Reactions with Long Life Time and High Efficiency Niranjanmurthi Lingappan[1, 2]; [1]Sungkyunkwan University, Korea (the Republic of); [2]Center for Integrated Nanostructure Physics, Korea (the Republic of).

ES13.8.10
α-Hematite -Molybdenum Disulfide Nanocomposite Films for Photoelectrochemical Applications Hussein S. Alrobei; University of South Florida, United States.

ES13.8.11
Silicon Nanoparticles-Conducting Hydrogel Composite Wrapped with Reduced Graphene Oxide as Anodes for Lithium-Ion Batteries Changling Li; University of California, Riverside, United States.

ES13.8.12
Using COMSOL to Study Electrochemical Dynamics at Electrode-Electrolyte Interface of a Lithium-Ion Electrode Bo Dong; University of California, Riverside, United States.

ES13.8.13
Efficient Nanostructured Brass for Water-Splitting Applications Dina S. Eissa; American University in Cairo, Egypt.

ES13.8.14
CeO_2 Doped FeN_x/C Catalyst with Enhanced Durability toward Oxygen Reduction Reaction Jianguo Liu; Nanjing University, China.

ES13.8.15
Using *In Situ* Neutron Reflectometry to Study Solid-Electrolyte Interphase Formation in aSi and Sn Anode Materials Jim Browning; Oak Ridge National Laboratory, United States.

ES13.8.16
Controlled Crystallization of Cesium Lead Halide Perovskite Films on Modified TiO_2 Surfaces for Photovoltaic Applications Kara Saunders; University of Arizona, United States.

ES13.8.17
***In Situ* Characterization of ZnO Formation during Electrodeposition of Zn** Dian Yu; University of California Los Angeles, United States.

ES13.8.18
Characterization of Lithium Batteries Electrodes Using Glow Discharge Optical Emission Spectrometry Matthieu Chausseau; HORIBA Scientific, United States.

ES13.8.19
Study of Cuprate Thin Film Heterostructures Combining $La_2CuO_{4+\delta}$ and $LaCuO_{3-\delta}$ for Fuel Cell Applications Nicholas A. Prill; University of St. Thomas, United States.

ES13.8.20
Selective Electrochemical Reactions on Superhydrophobic Plastron-Supporting Electrodes Hamed Mehrabi; University of Arkansas, United States.

ES13.8.21
Nanoscale Surface Evolution in Li-Rich Mn-Rich Layered Oxide Cathodes Chengcheng Fang; University of California, San Diego, United States.

ES13.8.22
Microscopic Origin of High Open Circuit Voltage in Solid State Dye Solar Cells with Polymer Electrolyte Tea-Yon Kim; Hanyang Univ, Korea (the Republic of).

ES13.8.23
Lithiation Mechanism and Lithium Storage Capacity of Reduced Graphene Oxide Nanoribbons—A First-Principles Study Chin-Lung Kuo; National Taiwan University, Taiwan.

ES13.8.24
Surface and Interface Engineering of Lithium Metal Anodes for Next Generation Secondary Batteries Taner Zerrin; University of California Riverside, United States.

ES13.8.25
Pushing the Cycling Stability Limit of Polypyrrole for Supercapacitors Tianyu Liu; University of California, Santa Cruz, United States.

ES13.8.26
Nanopores Reveal Interface and Mesoscale Ion Transport Properties of $LiClO_4$-PMMA Gel Timothy S. Plett; University of California, Irvine, United States.

ES13.8.27
Aqueous Solutions of Protic Ionic Liquids for Enhanced Stability of Polyoxometalate-Carbon Supercapacitor Electrodes Chenchen Hu[1, 2]; [1]Georgia Instititue of Technology, United States; [2]Huazhong University of Science and Technology, China.

ES13.8.28
Template-Free Synthesis of N, P and S Ternary-Doped 3D Aerogel of Graphene-Based Carbon as Excellent Electrocatalyst for the Oxygen Reduction Reaction Md. Selim Arif Sher Shah; Sungkyunkwan University, Korea (the Republic of).

ES13.8.29
Alkali Metal Fullerides—Applications in Electrochemical Energy Storage Kurumi R. Austin; The University of Arizona, United States.

ES13.8.30
All-Solid-State Batteries Based on Nanocrystalline $LiBH_4$ Marlena Uitz; Graz University of Technology, CD-Laboratory for Lithium Batteries, Austria.

ES13.8.31
Lower Symmetry Bimetallic (Co & Fe) Corrole N4 as an Efficient Electrocatalyst for Oxygen Reduction Reaction Satyanarayana Samireddi[2, 3]; [2]Academia Sinica, Taiwan; [3]National Tsing Hua University, Taiwan.

ES13.8.32
Improved Ionic Conductivity in NASICON-Type Sr^{2+} Doped $LiZr_2(PO_4)_3$ Sunil Kumar; Indian Institute of Technology Indore, India.

ES13.8.33
Molecular Ni-Complex Containing Tetrahedral Nickel Selenide Core as Highly Efficient Electrocatalyst for Oxygen Evolution Reaction in Alkaline Medium Manashi Nath; Missouri University of Science and Technology, United States.

ES13.8.34
Novel Battery Architecture for Next Generation Lithium Ion Battery Materials Based on Sulfur and Silicon Utilizing Smart Lithium Placement Rachel Ye; University of California, Riverside, United States.

SESSION ES13.9: Interfaces/Interphases—Characterization/Simulation
Session Chairs: Yuyan Shao and Lynn Trahey
Friday Morning, April 21, 2017
PCC North, 200 Level, Room 227 AB

8:15 AM *ES13.9.01
***In Situ* and Operando Investigations of Electrochemical Interfaces Using Ambient Pressure XPS** Ethan J. Crumlin[1, 2]; [1]Lawrence Berkeley National Laboratory, United States; [2]Lawrence Berkeley National Laboratory, United States.

8:45 AM ES13.9.02
Structures at the Solid–Ionic Liquid Interface—A Complementary X-Ray Reflectivity and Molecular Dynamics Approach Andreas Magerl; University of Erlangen-Nurnberg, Germany.

9:00 AM ES13.9.03
Ultrasensitive Probing of Local Electronic Structure in the Soft X-Ray Regime Dennis Nordlund; SLAC National Accelerator Laboratory, United States.

9:15 AM ES13.9.04
Ultrafast Current-Voltage Measurements in Scanning Probe Microscopy Suhas Somnath; Oak Ridge National Laboratory, United States.

9:30 AM ES13.9.05
Enabling Local Electrochemistry with Fast, High-Resolution Scanning Probe Microscopy Nathan D. Kirchhofer; Asylum Research, United States.

9:45 AM BREAK

10:15 AM *ES13.9.06
Understanding the Nature of Chemical and Electrochemical Stability of Electrolytes at Mg Anode Surfaces David Prendergast; Lawrence Berkeley National Lab, United States.

10:45 AM *ES13.9.07
Modeling Spatial Heterogeneity and Potential Effects at Battery Reactive Anode/SEI Interfaces Kevin Leung; Sandia National Laboratories, United States.

11:15 AM ES13.9.08
Validating Structure of the Solid/Liquid Interface with First Principles Molecular Dynamics and X-Ray Reflectivity Kendra Letchworth-Weaver; Argonne National Laboratory, United States.

11:30 AM ES13.9.09
Towards Realistic Continuum Models of Electrified Interfaces Artem Baskin[1, 2]; [1]Lawrence Berkeley National Lab, United States; [2]Lawrence Berkeley National Laboratory, United States.

11:45 AM ES13.9.10
Uncovering the Interfacial Properties of Hybrid Perovskite Films on Metal Oxides via Conductive Probe AFM James G. Stanfill; University of Arizona, United States.

SESSION ES13.10: High Temperature Electrochemistry
Session Chairs: Yuyan Shao and Lynn Trahey
Friday Afternoon, April 21, 2017
PCC North, 200 Level, Room 227 AB

1:30 PM ES13.10.01
Improving Oxygen Electrocatalysis in Perovskite Thin Films by Epitaxial Strain Dongkyu Lee; Oak Ridge National Laboratory, United States.

1:45 PM ES13.10.02
***In Situ* Probing of Interfacial Phenomena in Solid Oxide Electrochemical Cells** Jiaxin Zhu; University of Massachusetts Amherst, United States.

2:00 PM ES13.10.03
Colloidal Nanocrystal Films as Model Materials for Intermediate Temperature Proton Conductivity in Porous Metal Oxides Gary K. Ong[2, 1]; [1]University of Texas at Austin, United States; [2]University of California, Berkeley, United States.

2:15 PM ES13.10.04
Interfaces in Doped $LaGaO_3$ and Their Impact on Solid Oxide Fuel Cell Performance Aoife K. Lucid; Trinity College Dublin, Ireland.

2:30 PM ES13.10.05
Evolution in Crystal Structure and Electronic Structure of Functional Oxides Probed *In Situ* during Electrochemically Driven Phase Transition Qiyang Lu[1, 2]; [1]Massachusetts Institute of Technology, United States; [2]Massachusetts Institute of Technology, United States.

2:45 PM ES13.10.06
Sodium-Based Batteries—Engineering Interfaces for Optimized Performance Erik D. Spoerke; Sandia National Laboratories, United States.

3:00 PM ES13.10.07
The Impact of Interfaces on Oxide Ion Diffusion in Doped Ceria Aoife K. Lucid; Trinity College Dublin, Ireland.