Two Upcoming Battery Industry Events

6th Annual International Conference

Lithium Mobile Power

November 4-5, 2010 • Boston, MA USA

Advances in Lithium Ion Battery Technologies for Mobile Applications

Battery Safety 2010

November 3, 2010 • Boston, MA USA

Advances in System Design, Integration & Testing For Safety & Reliability

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6th Annual International Conference

Lithium Mobile Power

Call for Sponsors & Exhibitors

November 4-5, 2010 • Boston, MA USA

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Attendees at this event represent the very top industry, government and academic researchers from around the world and provide an extremely targeted and well-qualified audience for exhibitors and sponsors. Your participation as an exhibitor or sponsor is the most cost effective way to gain high quality, focused exposure to these industry leaders. Among other benefits, sponsorship packages include your logo on marketing materials to promote your participation and expose your company to 10's of thousands of prospects prior to the program - in addition to the highly targeted audience we deliver at the event itself.

CONFERENCE SPONSORSHIPS

A variety of conference sponsorships are available which offer incremental levels of visibility to conference delegates at the event — as well as opportunities for marketing exposure prior to the event. Taking advantage of pre-conference options has the added benefit of getting your organization's name out to a large group of interested decision makers.

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Call Craig Wohlers at (617) 232-7400 ext. 205 or email cwohlers @ knowledgefoundation.com today for pricing information and customization options.

CALL FOR POSTER PRESENTATIONS

Industry and academic scientists are encouraged to submit poster titles for this event. One-page abstracts (8 1/2" x 11" with 1-inch margins) must be submitted by email to submit @ knowledgefoundation.com no later than **October 8, 2010** for inclusion in conference documentation. Additional poster submissions will be accepted until **October 25, 2010** but may not be included in conference documentation. *Note: If you are submitting a poster, you MUST be registered and paid in advance to ensure that a posterboard is reserved for you.*

COMPREHENSIVE DOCUMENTATION AVAILABLE

Nothing can substitute the benefits derived from attending **Battery Safety & Lithium Mobile Power**. But if your schedule prevents you from attending, this invaluable resource is available to you. Please allow 3-4 weeks after the conference date for delivery. *Note: Documentation is included with conference fee for registered delegates.*

Conveniently Timed With

Battery Safety 2010

November 3, 2010
Boston, MA

Battery 2010 Safety

Conference Agenda

November 3, 2010 • Boston, MA USA

Wednesday, November 3, 2010

7:45 *Registration, Exhibit Viewing/Poster Setup, Coffee and Pastries*

8:35 **Organizer's Welcome and Opening Remarks**

8:45 **New Directions in Battery Safety: Prospects for Fail Safe Lithium-Ion**

Brian M. Barnett, PhD, Vice President, Technology, TIAX LLC

Highly publicized safety incidents and widespread recalls of lithium-ion batteries used in laptops and cell phones have raised concerns regarding lithium-ion battery safety. Even though these events occur at rates well below what would be predicted by six-sigma manufacturing perspectives, the seriousness of these incidents has properly raised the issue of safety with regard to use of lithium-ion batteries in transportation applications. From a perspective of carrying out many investigations and post mortems of lithium-ion safety incidents, TIAX has used a system approach to develop a series of technologies that pertain to pre-emption, detection, intervention and containment of the thermal runaway that takes place during these incidents. In this talk, we will describe some of the technologies being developed at TIAX targeting "fail safe" lithium-ion battery packs for portable and vehicle applications.

9:15 **Safety and Reliability in Chinese Manufactured Lithium-Ion Cells**

Steven Ruth, Vice President, China BAK Battery, Inc., PR China

With safety and reliability of lithium cells considered givens in today's portable device market, how does the designer know the cell manufacturer has control over its processes? An analysis and control methodology, focused on measured continuous improvement, is presented.

9:45 **Mitigating Catastrophic Failure in Lithium-Ion Cells**

Christopher J. Orendorff, PhD, Power Sources Technology Group, Sandia National Laboratories

Safety issues with lithium-ion cells are independent of any performance metric and may prevent the widespread adoption of these technologies for electric vehicles (EV) and plug-in hybrid electric vehicles (PHEVs). Despite the historical concerns with high-energy materials for lithium-ion batteries (e.g. high rate thermal runaway, internal short circuits, flammability, etc.), strides have been made to improve the inherent safety of these materials in full cells. Approaches for abuse tolerant materials and techniques to mitigate the common abuse and field failure modes will be presented.

10:15 *Networking Refreshment Break, Exhibit/Poster Viewing*

10:45 **Navy Large Form Lithium Battery Safety Initiatives - Recent Developments**

Clinton Winchester, PhD, Group Leader & Senior Technologist, Naval Surface Warfare Center (NSWC)*

Abstract not available at time of printing. Please visit www.KnowledgeFoundation.com for the latest Program updates.

*In collaboration with: Julie Banner, Daphne Fuentevilla, et al.

11:15 **Battery Safety and Abuse Tolerance Test Procedures - Test Methods and Test Current Standards**

Daniel H. Doughty, PhD, President, Battery Safety Consulting, Inc.

Battery safety and abuse tolerance test procedures are designed to simulate the effects of off-normal events that may occur, however unlikely, during use of battery-powered devices. Test procedures include mechanical, thermal and electrical abuse conditions. Test procedures may be "Characterization Tests", where the test article is brought to failure and the results scored to determine the severity of response, or "Pass/Fail Tests", where the test article is exposed to specific abusive conditions and the response, if it meets or exceeds test standards, provides the basis of approval for shipping or use in a commercial device. The presentation will discuss the origin of test procedures and compare existing test procedures that are used for portable electronics as well as automotive applications.

11:45 **Safety Limitations Associated with Commercial 18650 Lithium-Ion Cells**

Judith A. Jeevarajan, PhD, Senior Scientist - Battery Office, NASA Johnson Space Center

Commercial 18650 lithium-ion cells are used in numerous portable equipment batteries. These cells are tolerant to abusive conditions of overcharge, external short and overdischarge in single cell or small battery configurations (low voltage, low capacity). However, the protective features inside these cells either do not protect or themselves become a source of hazard when the cells are configured into high voltage/high capacity modules. The author will present the hazards associated with these cells under various off-nominal conditions.

12:15 **Prediction of Multiphysics Behaviors of Large Lithium-Ion Batteries at Internal and External Short Circuit**

Gi-Heon Kim, PhD, Senior Research Engineer, Advanced Vehicles Group, Center for Transportation Technologies & Systems, National Renewable Energy Lab

This talk will describe the methodologies of NREL's lithium-ion battery short modeling, and then present analysis results for cell response study and multi-cell pack response study. In our multiphysics model approach, competing mechanisms between heat release from component decomposition reactions at high temperatures and heat dissipation through spatial variation of material distributions are captured. Electrochemical responses of shorted cell are resolved by solving lithium diffusion dynamics and charge transfer. Three dimensional pathways of electrical current flow in a system are solved to evaluate joule heating from short current. For the extended pack level study, we developed an integrated network model resolving highly coupled thermal-electrical (electrochemical) responses from individual cells and inter-cell interactions. Multi-node thermal model for the selected cell was developed to capture critical temperature distribution in a cell. The simulation results imply that evolution of a internal short circuit and the thermal, electrical, chemical response of a lithium-ion cell for the short strongly depend on the nature of short itself, the characteristics of the shorted cell, and even the way of integration of the cell in the system.

12:45 *Lunch*

2:00 **BMS-Centered Battery Safety and Reliability**

Larry Yount, Chief Technical Officer, Critical Control and Reliable Electronic Systems, LaunchPoint Technologies*

This paper describes enabling technology for increased Li-ion energy storage capacity though intelligent control. Also addressed are both reliability and safety, ensuring that the battery will not experience a failure with the potential for serious injury. Benefits include: (a) Virtual elimination of the safety issue (< 10^{-9}/hour); (b) Systemically enhanced reliability; approaching a BMS MTBF of 1,000,000 hours; (c) Significant increase in useable battery capacity, using physics and electrochemistry-based modeling.*In collaboration with: Ralph White, University of South Carolina

2:30 **Thermo-Chemical Process Associated with Electro-Active Materials/Electrolyte and Recent Developments towards Safe Lithium-Ion Battery**

Angathevar Veluchamy, PhD, Scientist, Central Electrochemical Research Institute, India

Lithium ion battery upon overcharge/overdischarge following any inadvertent conditions causes release of oxygen from the oxide cathode, destruction of solid electrolyte interface, exothermic conversion of lithium in graphene layers into its oxide, combustion of organic electrolyte leading to thermal runaway, failure or explosion of the battery. This presentation also focuses on the latest developments that conceptualize safe lithium-ion battery for stationary and electric vehicle applications, in addition to portable gadgets, thus providing green energy and better environment for the lives on the earth.

3:00 **Advanced Electrolyte Additives to Enhance the Safety of Lithium Ion Batteries**

Zonghai Chen, PhD, Chemist, Electrochemical Energy Storage Group, Chemical Sciences & Engineering Division, Argonne National Laboratory

Safety issues have been one of the major technological barriers for lithium ion batteries to power HEVs and EVs. This talk will cover our updated progress on searching for advanced electrolyte additives for safer lithium ion batteries. The additives to be discussed include (1) those to form stable SEI film on carbon anodes, and (2) redox shuttles for overcharge protection and automatic capacity balancing.

3:30 *Networking Refreshment Break, Exhibit/Poster Viewing*

4:00 **Deciphering Cell Variations in Battery Manufacturing**

Matthieu Dubarry, Cyril Truchot, and Bor Yann Liaw, University of Hawaii at Manoa, Hawaii Natural Energy Institute

Rechargeable battery market is expected to see significant growth in sectors of portable devices and power electronics, renewable energy storage, powertrain systems for vehicles, and telecom backup power applications. Complex use of battery systems is also expected, where battery system safety and management remain challenging issues. Both battery system reliability and safety depend on more insightful understanding of battery degradation. We have previously reported successful application of incremental capacity analysis and using relaxed cell voltage to determine battery state of charge [1-3]. Recent battery testing results show that capacity degradation in a battery is more interrelated than what we previously thought. In this presentation, we discuss an improvement in the in situ inference of battery degradation mechanism based on loss of active material in the electrode, which subsequently induces other effects that lead to additional capacity degradation.

4:30 **EV Cells and Modules - Thermal Safety & Issues**

Jeff Rachford, Thermal Hazard Technology, United Kingdom

Calorimetry, specifically the ARC with large volume calorimeters quantify effect of heat on and heat release by large format EV Lithium batteries. Latest developments to be discussed are: (a) Thermal Stability of Large Format Cells;
(b) Pressure Development and Gas Release (collection and analysis); (c) Specific Heat Capacity Measurement; (d) Calorimetry for Thermal Management; (e) Accident Crush and Penetration Simulation Heat Effects; (f) Heat Release from Drive Cycle Simulation; (g) Surface Heat Distribution Determination.

Battery Safety 2010

Conference Agenda

November 3, 2010 • Boston, MA USA

Wednesday, November 3, 2010 from 5:05pm-7:30pm

SPECIAL WORKSHOP & EQUIPMENT DEMONSTRATION SESSION

Sponsored by:
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5:05 A SPECIAL WORKSHOP AND EQUIPMENT DEMONSTRATION SESSION**:**

New Tools and Techniques for Making Inherently Safer Large and Small Format Li-ion Batteries - A Guide to Better Battery Design Using Thermal Analysis and Calorimetry - Part 1

- Testing Needs and Special Testing Requirement
- DSC, TGA & Evolved Gas Analysis (via Mass Spec & FTIR) and Thermal Conductivity Techniques
- Adiabatic Calorimetry and Introducing a New Multi-Mode Benchtop Calorimeter

6:15 *Oktoberfest Refreshment Break (featuring sausage, pretzels and beer)*

6:35 **New Tools and Techniques for Making Inherently Safer Large and Small Format Li-Ion Batteries - A Guide to Better Design Using Thermal Analysis and Calorimetry - Part 2**

- Isothermal Calorimetry Techniques
- Putting It All Together: Using Modeling to Understand Field Failure

The growth of Li-ion battery development field has created a demand for new and innovative approaches to thermal analysis. New methods, instruments, and software are introduced to help battery researchers manage the increasingly more challenging battery applications. New techniques provide insight into the development process, increasing productivity and making cells and batteries inherently safer and more functional. Some thermal analysis and calorimetric techniques have been well used but we find oftentimes they are misused or underused. There are numerous lessons available from years of work in chemical process development and safety which can be applied to this field. This presentation will cover the strengths and weaknesses of some selected techniques, how they are best used and where the technology is heading.

7:30 *End of Workshop*

Thursday, November 4, 2010 - 6:00pm-9:00pm

6:00 A SPECIAL WORKSHOP SESSION**:**

An Introduction to Assessment of Batteries & Materials Using Calorimetry and Thermal Analysis

Sponsored by: ***Setaram Instrumentation***

6th Annual International Conference

Lithium Mobile Power

Conference Agenda

November 4-5, 2010 • Boston, MA USA

Thursday, November 4, 2010

8:00 *Registration, Exhibit Viewing/Poster Setup, Coffee and Pastries*

8:50 **Organizer's Welcome and Opening Remarks**

9:00 **Metal Fluoride Conversion Nanocomposites: An Alternative Road for Lithium Based Energy Storage**

Glenn G. Amatucci, PhD, Professor, Director, CASSI / ESRG, Dept of Materials Science and Engineering, Rutgers University

Metal fluoride electrodes have been of interest as high energy density electrodes for lithium batteries for over three decades, however, the theoretical electrochemical activity of such materials remained elusive as a result of their high bandgap and poor charge transport characteristics. Our laboratory first introduced the use of electronically and mixed conducting matrices to form nanocomposites of such materials which resulted in the revelation of the theoretical voltages and high energy densities of some of the most promising fluorides and oxyfluorides. This presentation will overview the science, practical performance, and the remaining challenges of a few attractive yet contrasting fluoride electrodes.

9:30 **Panasonic's Advanced Lithium Ion Batteries**

Koshin Hosoki, Engineer, Lithium-Ion Battery Business Unit, Energy Company, Panasonic Corporation

Lithium ion batteries have attracted a great deal of public attention as the key devices for realizing 'green-energy' society. We have developed new technologies for advanced batteries. 1) Ni based oxide New Platform (NNP) as high energy technology; 2) Panasonic Solid Solution (PSS) as high reliability technology; 3) Heat Resistance Layer (HRL) as high safety technology. In this presentation, we report the performance of lithium ion battery using these technologies, and introduce our product lineup.

10:00 **Proactive Remedies to Battery Thermal Runaways**

Rachid Yazami, PhD, Research Director at CNRS; Visiting Associate in Engineering, California Institute of Technology

'Entropymetry' is a new electrochemical technique that consists on analyzing the temperature dependance of OCV at different battery states of charge. The resulting entropy profile bears highly accurate information on phase transitions taking place at the anode and the cathode and as such, can be used to identify the battery chemistry, determine its state of charge and its state of health. Onsets of electrode materials degradation can be seen in the entropy signature and be used proactively to assess risks of battery thermal runaway and potential catching fire and/or exploding. We will discuss the usefulness of entropymetry in the crucial safety aspect.

10:30 *Networking Refreshment Break, Exhibit/Poster Viewing*

11:00 **Battery Management Solutions for New Lithium Chemistries & Applications: Power Tools to HEVs, Li-Phosphate to Li-Titanate**

Dan Friel, Sector Manager, Battery Management Solutions, Texas Instruments

Lithium rechargeable batteries are finding use in more and diverse applications ranging from power tools to hybrid electric vehicles. New chemistry formulations such as Li-phosphate and Li-titanate are also being developed for these devices. But unlike traditional laptop and cell phone battery management systems, these new applications and chemistries require different battery management architectures that may segment monitoring, protection, measurement, calculation, and control. This presentation will discuss the common design challenges and illustrate how to select the right architecture and components for these applications and chemistries.

11:30 **High Throughput Synthesis and Screening for Discovery of Improved Electrode Materials for Lithium-Ion Batteries**

Steven Kaye, PhD, Chief Scientific Officer, Wildcat Discovery Technologies

Wildcat has developed a platform for combinatorial synthesis and screening of battery materials that can evaluate >1500 cells/week. Wildcat's system produces materials in bulk form rather than thin films, enabling formulation of active material into electrodes and evaluation of properties in complete cells. This allows rapid development of the active materials, formulation, and electrolyte. Here, I will discuss Wildcat's materials development program, including results from our first electrode material libraries.

12:00 **High Energy Density Li/CFx Battery Technology**

Mario DeStephen, PhD, Director of R&D, Eagle Picher Technologies*

The Li/CFx system attracts extensive attention due to its highest specific capacity, and long shelf life. However, due to the intrinsic physicochemical properties of CFx materials, Li/CFx batteries have been limited to low rate applications and narrow operation temperature range. This paper describes the work at Eagle Picher Technologies on the development of high performance Li/CFx systems capable of delivering high capacity at high discharge currents with wide operational temperature range.
*In collaboration with: Hyun Bang, Dong Sun, Dong Zhang

12:30 *Luncheon Sponsored by the Knowledge Foundation Membership Program*

2:00 **How Nanotechnology Will Revolutionize Lithium Ion Batteries for Electronics**

Jurgen Hofler, PhD, VP of Operations and Engineering, Nanosys, Inc.

Lithium ion batteries will power our future's electronics and electric vehicles, and enhance energy storage. However, progress in storage specific capacity has been limited to only 6% improvement per year over the past two decades. We will outline

the science behind how Nanosys's process-ready silicon nanowire composite additive, SiNANOde™ technology can increase specific storage capacity by 25% in a single cost-effective step when added to the anode of the battery.

2:30 **3x Capacity from Silicon-Nanowire Based Lithium Ion Batteries**

Yi Cui, PhD, Associate Professor, Nanomaterials Science and Engineering, Dept of Materials Science & Engineering, Stanford University; and Lead Scientific Advisor, Amprius, Inc.

Amprius is developing breakthrough silicon nanowire-based anode technology from Stanford University, paving the way for commercially viable next generation lithium ion batteries capable of 3x the energy density available from today's state of the art lithium ion batteries. Amprius will show previously unreleased data related to energy density and cycle life in prototype battery cells exceeding 1000mAh/g and 1000 cycles with minimal performance degradation, as well as discuss mitigation strategies, solutions, and data regarding cycle life degradation in silicon-based LIBs.

3:00 **Structural Silicon Anode Materials for PHEV Applications**

Michael J. Lain, PhD, Nexeon Ltd, United Kingdom

Structural silicon anode materials offer significantly higher capacities than conventional carbon anodes, as either fibres or pillared particles. They can be manufactured by a wet chemical etching process, at a competitive cost. Composite structural silicon anodes using polymeric binders can be cycled over several hundred cycles, in full cells with standard cathode materials. Initial results will be presented evaluating these materials on representative PHEV duty cycles, e.g. charge depleting and charge sustaining modes.

3:30 *Networking Refreshment Break, Exhibit/Poster Viewing*

4:00 **Advanced Anode Graphites for High Performance Batteries**

Bharat S. Chahar, PhD, PE, Product Manager, ConocoPhillips Company

ConocoPhillips is continuing to expand the availability of targeted anode materials for high performance Li-ion batteries by introducing several new grades of of CPreme® graphite products. These new grades provide more flexibility to battery makers while advancing performance and lowering costs. This presentation will discuss the new features of CPreme® anode materials and how these features will help broaden the adaptation of Li-ion batteries.

4:30 **Simple Modular Lithium Nanophosphate Battery Systems**

Roger Lin, Director of Product Marketing, A123 Systems, Inc.

A123 Systems is developing a family of fully integrated, managed batteries based on A123's Nanophosphate™ lithium-ion cells designed for integration into a variety of different applications, including backup power. The advantages of an off-the-shelf, integrated scalable modular battery system using A123's Nanophosphate™ energy storage include high durability, long cycle life, high power delivery, and high abuse tolerance and safety, making it an attractive solution to energy storage needs.

5:00 **Lithium Air Batteries: Development of a Functional 3-Dimensional 3-Phase Gas-Diffusion-Electrode in Non-Aqueous Electrolyte**

Deyang Qu, PhD, Assistant Professor, Dept of Chemistry, UMass Boston

The gas-diffusion-electrode used in a Li-air cell has been studied in a unique home-made electrochemical cell. Three major obstacles for the development of a feasible Li-air system were discussed with a focus on the development of a functional gas-diffusion-electrode in non-aqueous electrolytes and the way of avoiding the passivation of gas-diffusion-electrodes caused by the deposition of the reduction products. The importance of establishing the 3-phase electrochemical interface in non-aqueous electrolyte is demonstrated by creating air-diffusion paths and an air saturated portion for an air-cathode.

5:30 **The Regulatory Maze of Lithium Ion**

Tom O'Hara, Intertek

This paper discusses the regulatory maze which now exists, created by a number of separate organizations to help protect ourselves and others from the hazards associated with batteries and cells. And this need has been highlighted in recent years because of highly publicized incidents and recalls involving lithium ion batteries. The list of regulations can be overwhelming and confusing. We hope this general overview helps provide some level of clarity and understanding.

6:00 *Networking/Refreshment Break Workshop Set-up*

Thursday, November 4, 2010 - 6:00pm-9:00pm

6:00 A SPECIAL WORKSHOP SESSION:

An Introduction to Assessment of Batteries & Materials Using Calorimetry and Thermal Analysis

Sponsored by: ***Setaram Instrumentation***

SETARAM Instrumentation
KEP Technologies

Friday, November 5, 2010

7:30 *Exhibit Viewing/Poster Setup, Coffee and Pastries*

8:30 **NCM Cathode Materials for High Energy Density as well as Safety Relevant Applications Such as e-Mobility**

Kirill G. Bramnik, PhD, Global Product Technology Manager, Battery Materials, BASF Corporation

NCM (Nickel-Cobalt-Manganese based oxides) cathode materials employ a unique combination of lithium and manganese rich mixed metal oxides in a revolutionary materials-design approach to extend the operating time between charges, increase the calendar life and improve the inherent safety of Li-Ion cells. Moreover, the enhanced stability of the NCM chemistry enables development of new battery systems, which can be charged to higher voltages and leads to a substantially higher energy storage capacity than currently available material through higher capacity per unit weight of active material. Due to very high degrees of purity and excellent product characteristics, the BASF materials are well suited for demanding applications such as batteries for automotive drivetrains.

9:00 **TIAX CAM-7 High Capacity, High Power Cathode Material**

Brian M. Barnett, PhD, Vice President, Technology, TIAX LLC

For several years, TIAX has been developing a stabilized nickelate cathode material that provides a unique combination of both high capacity and high power, and is an excellent option for portable, transportation and specialty applications. Production of CAM-7 has involved novel control of synthetic conditions to achieve control of materials properties in a low cost process. The material has been implemented in cells by multiple battery manufacturers and a variety of "traditional" problems associated with performance and handling of nickelate compounds have been addressed. In the process of implementation of CAM-7 over the last year, TIAX has made a number of adjustments in the composition and process by which CAM-7 is synthesized. This presentation will discuss new data regarding performance, safety testing and implementation considerations for CAM-7.

9:30 **Cathode Materials Degradation Mechanism from Thermodynamics and Crystal Structure Studies**

Yasunori Baba, Chief Researcher, Sho Tsuruta, Researcher, Katsunori Yanagida, Manager, and Hiroshi Nakamura, PhD, Senior Manager, SANYO Electric Co., Ltd., Japan; and

Rachid Yazami, PhD, Research Director at CNRS; Visiting Associate in Engineering, California Institute of Technology

Conventional layered oxide cathode (e.g. LiCoO2) gives a capacity of ~160mAh/g when charged to 4.3V vs. Li/Li+, corresponding to ~60% of theoretical capacity. Increasing operating potential is one method to increase usable capacity of the active material. However, structural change of the material at potential above 4.5V vs. Li/Li+ could limit reversibility of Li intercalation. Electrochemical entropy measurement has been used to study the structural change of LixMO2 (where M is a transition metal) up to 4.6V vs Li/Li+ where most of the Li atoms are extracted. We will discuss the phase transition and degradation mechanism of layered cathode materials.

10:00 **Large Format $Li_4Ti_5O_{12}$ Lithium Ion Batteries - Performance and Applications**

Veselin Manev PhD, Director R&D, Altairnano Inc.

The performance of high rate long life cells with nano-$Li_4Ti_5O_{12}$ negative electrodes developed for both automotive and stationary power application will be discussed. Cycle life and calendar life performance data will be presented. Data from accelerated calendar life test measurement performed for more than 30 months, suggesting capacity fade below 1% after 25 years calendar life at room temperature will be displayed. Data for elevated temperature cycling performance and self-discharge rate will be also presented. Performance of battery system using these large format cells will be also discussed.

10:30 *Networking Refreshment Break, Exhibit/Poster Viewing*

11:00 **Primary and Secondary Lithium-Air Batteries Based on Water-Stable Lithium Metal Electrodes**

Steven J. Visco, PhD, Chief Technical Officer and Vice President, PolyPlus Battery Company*

This presentation will address the various approaches to the development of rechargeable lithium-air batteries and the benefits and drawbacks of each technology. In the 1990s PolyPlus invented the protected lithium electrode which enables the practical development of high energy density lithium/aqueous battery technologies, including primary and secondary lithium-air. It also allows greater flexibility in the development of rechargeable non-aqueous Li-Air in that a much larger selection of non-aqueous solvents and electrolytes can be used. PolyPlus is developing both aqueous and non-aqueous rechargeable Li-Air technology and will discuss the relative merits of these different chemistries. Li-O2 chemistry can achieve extremely high energy densities, achieving greater than 800 Wh/kg for 2 Ah Li-Air laboratory cells and 1300 Wh/kg for 13 Ah Li-Water battery packs. * In collaboration with: E.S. Nimon

11:30 **Materials for Enhancing the Safety and Performance of Li-Ion Cells**

Ratnakumar V. Bugga, PhD, Principal Member Technical Staff, Electrochemical Technologies Group, Jet Propulsion Laboratory, California Institute of Technology*

For the upcoming NASA missions that will involve human exploration, there is a need to improve the safety of Li-ion cells, in addition to enhancing their performance. Under a NASA-sponsored program and in collaboration with other centers (NASA-GRC, and JSC), universities and industry partners, we, at JPL, have undertaken studies on developing new cathode materials with enhanced thermal stability and new electrolyte formulations with reduced flammability. In this presentation, we will present the safety and performance characteristics as well as basic electrochemical studies of the materials in laboratory cells.

*In collaboration with: W. West, M.C. Smart

12:00 **Structural Changes during Heating and Cycling of Layer-Structured and Olivine-Structured Cathode Materials Studied by HRTEM and In Situ XRD and XAS**

Xiao-Qing Yang, PhD, Principle Investigator, Chemistry Dept; & Kyung-Wan Nam, PhD, Scientists, Brookhaven National Laboratory*

We report our studies on the structural changes in cathode materials during heating with and without electrolytes, as well as the structural differences between the surface and the bulk during heating. Our studies on Co, Al, Mn doped $LiNiO_2$-based materials using time-resolved X-ray diffraction (XRD) and X-ray absorption spectroscopy (XAS) show phase transformations during heating. Due to averaging nature of X-ray techniques, detailed information about how the structure changes initiated and propagated through new phase nucleation and growth in the microscopic level is quite limited. We present our in-situ HRTEM studies on the structural changes of over charged $Li_{0.0}Ni_{0.8}Co_{0.15}Al_{0.05}O_2$ and $Li_{0.0}Ni_{1/3}Co_{1/3}Mn_{1/3}O$ cathode materials during heating, in comparison with our XRD and XAS studies. Rock-salt structure and spinel structure, which only observed at elevated temperatures using X-ray techniques, were presented at the edges and thin areas of the particles, respectively even at room temperature. This implies that after overcharging, the particles start losing some oxygen atoms near the particle surface, resulting in the structural changes. More detailed structural changes during heating will also be reported. The in depth understanding of the structural changes during charge-discharge cycles will provide guidance for developing new materials. Using synchrotron based in situ XRD, hard and soft x-ray XAS, and TEM, the structural changes of these materials have been studied during charge-discharge cycling. The differences of phase transition processes between the surface and the bulk will be discussed. *In collaboration with: X.J.Wang, Y.N.Zhou, H.S.Lee, L.J.Wu, Y.Zhu, BNL, and H.Li, X.Huang, L.Chen, Inst. of Physics, CAS, PR China

12:30 **Advanced Manufacturing Process for High Speed Deposition of Solid State Electrolyte Layers for Li-Based Batteries**

Susie Eustis, PhD, Research Scientist, and Derek Hass, PhD, Director of R&D, Directed Vapor Technologies International, Inc.

Gas jet assisted physical vapor deposition processes have been demonstrated to enable a unique combination of high deposition rates (up to 80μm/min.), high coating quality (compositionally and microstructurally controlled) and non line-of-sight deposition. One such approach, Directed Vapor Deposition, has recently been used to create thin (~10^{-}μm) LiPON electrolytes (as well as $LiMnO_2$ cathodes) with ionic conductivities in the 10^{-6} S/cm range while achieving deposition rates >40x those of RF sputtering. Results showing the dense coating structure, composition and ionic conductivity will be presented.

1:00 *Lunch on Your Own*

2:00 **Thermal Stability of Lithium-Ion Cells as Functions of Chemistry, Design and Energy**

Kevin C. White, PhD, Senior Managing Scientist, Exponent, Inc.

This presentation compares the thermal stability of commercially available 18650 cells. The results are compared with respect to contributions from cell chemistry, cell design and stored energy. Lithium cobalt dioxide based cells with designs optimized for applications ranging from high rate to high capacity were compared to high power $LiFePO_4$ cells. It was found that the thermal stability is a strong function of stored energy and the degree of graphite lithiation, and is relatively independent of positive electrode chemistry.

2:30 **Application Driven Complex Lithium-Ion Power Systems Development and Integration**

William J. Yalen, Li-ion Systems Program Manager/Lead Program Engineer, Yardney Technical Products, Inc. / Lithion, Inc.

Application driven development of advanced mobile Lithium-ion power systems and integration of new technological capabilities requires clear understanding of specific application requirements, detailed yet flexible planning, careful balancing of aggressive advancement goals vs. associated risks, and effective coordination of diverse multi-disciplinary teams. Like a high-performance engine, even with the right parts, the difference between success and failure can be a matter of fine timing and balance to ensure smooth meshing of all components to achieve overall success. Key technological, product development, and project management factors will be presented, as they relate to specific examples of state of the art capability developments for high-power / high energy / high performance aircraft, submarine, spacecraft, military, medical, and vehicular applications.

3:00 **Advanced Technologies for Li-Ion Battery Formation/Grading Process**

John Tessitore, Chroma ATE Inc.

A discussion of key features for the Battery Formation and Grading process which overcome the hurdles present in the current manufacturing process including the following technologies: 1) Redundant DC Power Sources; 2) Energy Recycling of the DC Discharge Energy; 3) Real Time test probe status monitoring; 4) Battery Voltage Tracking of linear-charging sources; 5) Single fault over-charge prevention; 6) Temperature compensation for capacity grading.

3:30 *Refreshment Break, Exhibit/Poster Viewing*

4:00 **Computer Aided Engineering for Battery Design**

Steve Hartridge, Director, Electric & Hybrid Vehicles, CD-adapco, United Kingdom

The increasing electrification of vehicles has provided a new challenge for numerical simulation techniques within this automotive design process. As the installation of an increasingly significant battery represents one of the largest design changes to modern vehicles, and also a noticeable increase in cost, there is considerable demand for such technology. The talk will detail the state of the art in this simulation field.

4:30 **Efficient and Accurate Computational Tools for Evaluating Performance Targets of Lithium-ion Cells and Cell Components**

Kevin L. Gering, PhD, Principal Investigator, Applied Battery Research, Energy Storage & Transportation Systems, Idaho National Laboratory

Increasing materials research worldwide calls for a commensurate increase in computational tools that keep pace with battery technology development. This presentation covers two key areas: electrolyte characterization and optimization, and a generalized approach toward characterizing and predicting cell aging

processes. Key electrolyte properties and parameters (transport, thermodynamics, ion solvation, molecular-scale interactions) are provided by our Advanced Electrolyte Model that has a basis in molecular-scale chemical physics. Aging processes are investigated through synergistic combinations of diagnostic testing and mechanism-based models.

5:00 **Evaluation Protocols of Micro-Scale Energy Storage Systems for Wireless Sensor Systems Applications**

Valer Pop, Dr Ing, IMEC Micropower, The Netherlands*

The development activities of high-energy density micro-scale energy storage systems (ESS) have been rapidly growing over the last decade. However, standardized test methods to compare the ESS performances of different developers are not available. This presentation will discuss - New ESS evaluation protocols tailored for wireless sensor systems applications - Benchmarking results of various ESS - ESS selection for integration. To the best of our knowledge, an evaluation protocol for micro-scale ESS is proposed for the first time and validated under application-oriented test conditions. *In collaboration with: R. Elfrink, C. De Alwis, R. van Schaijk, R. Vullers

5:30 **Selected Oral Poster Highlights & Discussion**

6:00 *End of Conference*

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