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7th Annual International Conference

Lithium Battery Power[SM] 2011

November 7-8, 2011
Las Vegas, NV USA

Conference Program

Recent significant innovations within lithium-ion batteries have propelled the technology into a position in the marketplace far exceeding recent market survey results. Breakthroughs in new battery chemistries, novel electrode and electrolyte materials, system integration for a vast array of mobile and portable applications, from micro medical devices to high-energy/high-power automotive, have paved the roadmap for an emerging market with unlimited potential. Lithium Battery Power 2011 is conveniently timed with Battery Safety 2011.

- Application driven lithium ion battery development
- New lithium chemistries for better electrodes and higher LIB performance
- Advanced lithium ion battery technologies for higher safety, reliability and performance
- From novel materials and components to systems design and integration
- Role of nanotechnology in improving power and energy density
- Novel electrolyte technologies for higher power and energy density

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Conference Agenda

Monday, November 7, 2011

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

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

9:00 **Rechargeable Batteries for the 300-Mile Electric Vehicles and Beyond**

K.M. Abraham, PhD, Chief Technology Officer, E-KEM Sciences

Today's lithium ion batteries are unable to satisfy the energy density and cost requirements of 300-mile all-electric vehicles. New rechargeable batteries have to be identified and developed in order to meet this challenge. A brief update of lithium ion technology will be provided with its energy density and cost evolution in the foreseeable future. New materials and battery systems for meeting the driving range of extended range all-electric vehicles will be discussed along with updates on the rechargeable Li-air and Li-sulfur batteries.

9:30 **Recent Advances in Rechargeable Battery Technology: An Overview**

Ralph J. Brodd, PhD, Director, Kentucky - Argonne Battery Manufacturing Research and Development Center

Recent work on new electrode materials and structures will be reviewed along with comments and the implication for their ability to meet demands for the high performance, cycle life as well as cost for electric vehicle applications. The increased interest in electric vehicle batteries has stimulated significant new work on cell components, including anodes, electrolytes and separators. A potential issue is available resources relating to the supply critical elements for large scale vehicle cell production. While the availability of lithium resources is assured, other elements such as nickel and cobalt will require consideration and recycling as the market expands. Exciting new systems such as lithium alloy anode materials and lithium - air cells are beginning to challenge Li-ion system for utility in vehicle applications.

10:00 **Subsonic Ultra Green Aircraft Research (SUGAR) Study Results: Hybrid Electric Propulsion with Advanced Battery Technology**

*Marty Bradley, PhD, Technical Fellow, Principal Investigator, Subsonic Ultra Green Aircraft Research The Boeing Company**

This presentation summarizes the work accomplished by the Boeing Subsonic Ultra Green Aircraft Research (SUGAR) team in a NASA study looking at future concepts and technologies for commercial aircraft in the 2030-2035 timeframe. The team developed a comprehensive future scenario for world-wide commercial aviation, selected baseline and advanced configurations for detailed study, generated technology suites for each configuration, conducted detailed performance analysis, calculated noise and emissions, assessed technology risks and payoffs, and developed technology roadmaps for key technologies. A wide portfolio of technologies was identified and evaluated to address the NASA goals. The highest payoff technologies were identified as hybrid-electric gas turbine propulsion and advanced modular batteries. Compared to today's aircraft, fuel burn reductions of up to 90% and energy use reductions of greater than 55% are possible. To achieve this, significant advances in battery technology are needed and aviation specific challenges need to be addressed. The goal of this presentation is to begin a dialog between the aviation industry and battery technology and system experts to eventually enable the benefits identified in this study to come to fruition. **In collaboration with: D.Coates, Boeing; R.Delrosario, NASA Glenn Research Center; R.Wahls, NASA Langley Research Center*

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

11:00 **Zero-Volt Technology with High Power Characteristics**

Hisashi Tsukamoto, PhD, CEO, CTO and Co-Founder, Quallion LLC

Quallion has developed Zero-Volt™ technology (US Patent 6,596,439) for medical implantable Li-ion battery. This technology allows Li-ion battery deep discharged to "zero volt" and stored prolonged time, and be able to recharge without any damage. Quallion recently advanced this technology for high power Li-ion battery for military applications. We believe this technology can benefit calendar life and safety for various commercial applications
including EV.

11:30 **How Long Will Automotive Li-Ion Last In Real-World Applications?**

*Kandler Smith, Senior Researcher, National Renewable Energy Laboratory**

Laboratories run around-the-clock aging tests to try to as quickly as possible gain an understanding of how long new Li-ion battery designs will last under certain duty-cycles. Such tests, however, are generally accelerated and do not consider possible dwell time at high temperatures and states-of-charge. Furthermore, automotive duty-cycles are highly variable, making it difficult to span the realm of real-world duty-cycles in the laboratory. To overcome these issues, battery life-predictive models provide guidance as to how long Li-ion batteries may last under real-world electric-drive vehicle applications. Worst-case aging scenarios are extracted from hundreds of real-world duty-cycles developed from vehicle travel surveys. **In collaboration with: M.Earleywine, S.Santhanagopalan, A.Pesaran*

Conference Agenda

12:00 **How to Have Your Cake & Eat It Too - An Investigation into Innovation-Driven High Performance, Cost-Effective Battery Systems**

Gitanjali DasGupta, Manager, Electric Vehicle Division, Electrovaya, Canada

Large battery systems for automotive and utility applications is a rapidly developing market segment. The most pressing challenges for large-format applications are generally agreed to be lower battery cost and improved performance. In this paper, Electrovaya investigates the three pillars of the cost structure to demonstrate how advanced technology and clean manufacturing processes can drive both reduced cost and exceptional performance.

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

2:00 **Translating High Capacity Materials into High Energy Density, High Performance Cells**

Brian M. Barnett, PhD, Vice President, 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. This material has now been implemented in cells by multiple manufacturers of lithium-ion cells, a process that necessarily involved development of detailed cell designs as part of the implementation. Most materials developers are not able to make cells, and yet cell-level performance is the ultimate requirement and cell-level performance sets the most pertinent materials targets. We have found that a combination of cell design models and relevant experimental data can help bridge the gap to cell level performance and also set appropriate development targets. This presentation illustrates the challenge of identifying relevant active materials targets to deliver enhanced performance at the cell level. In addition to the impact of TIAX new stabilized nickelate-based cathode material at the cell level, the presentation puts in a cell-level context some of the other recent high capacity materials developments for lithium-ion anodes and cathodes.

2:30 **An Update on the Materials Development at JPL for Enhancing the Specific Energy and Safety of Li-Ion Cells**

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

For enhancing the future NASA missions that will involve robotic as well as human exploration, we will need rechargeable batteries with improved specific energy and safety. Under a NASA-sponsored program and in collaboration with other centers and external partners, we have been developing new cathode materials with higher voltage and enhanced specific energy, as well as electrolyte formulations with high voltage compatibility and reduced flammability. In this paper, we will present the performance characteristics as well as basic electrochemical studies of the materials in laboratory cells. **In collaboration with: W.West, M.C.Smart*

3:00 **NCM Cathode Materials with High Energy Density for the Emerging Automotive Market**

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

NCM (Nickel-Cobalt-Manganese based oxides) cathode materials for Li-ion batteries employ a unique combination of Lithium and Manganese rich mixed metal oxides and have successfully substituted LCO in many consumer applications. It is also the material of choice for large auto-batteries due to lower costs, intrinsically higher safety and extended cycling stability. Moreover, the enhanced stability of the NCM chemistry enables development of new battery systems, which can be charged to the higher voltages and leads to a substantially higher energy storage capacity than currently available materials. The increased capacity of such materials goes hand in hand with reduced costs and therefore offers a number of advantages for battery makers. Dedicated design of particles together with high purity makes BASF materials well suited for demanding applications such as batteries for automotive drivetrains.

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

4:00 **Discovery of 5V Cathode and Electrolyte Materials via High Throughput Methods**

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

Wildcat Discovery Technologies has developed a high throughput synthesis and screening platform for battery materials. Wildcat's system produces materials in bulk form, enabling evaluation of its properties in a standard cell configuration. This allows simultaneous optimization of all aspects of the cell, including the active materials, binders, separator, electrolyte and additives. Wildcat is using this high throughput system to develop new electrode and electrolyte materials for a variety of battery types (primary, secondary, aqueous, non-aqueous). In this talk, I will discuss results from our latest discovery programs, including new 5V cathodes and electrolytes with >700 Wh/kg and significantly improved cycle life in full cells.

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4:30 **Application Driven Lithium-Phosphate Technology Development for Next Generation High-Power Lithium-Ion Batteries**

Speaker to be confirmed

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

5:00 **Transition Metal Oxynitride as Electrode Material for Rechargeable Li-Ion Battery**

Xiao-Jun Wang, PhD, and Reinhard Nesper, Prof Dr, Laboratory of Inorganic Chemistry, Swiss Federal Institute of Technology (ETH), Switzerland

Transition metal oxides have been widely studied as promising electrode materials in Li-ion batteries. In principle, transition metal oxynitrides have better electrical conductivity and higher theoretical capacity than oxides. But they are investigated rarely due to their crystal structural instability and restricted chemical synthesis method. In this talk, synthesis and characterizations of nanoparticles of niobium (V) oxynitride, namely NbON, will be presented, and the electrochemical behaviors vs. lithium will be discussed as well. NbON has the baddeleyite (ZrO2) structure with monoclinic symmetry (space group P21/c). Nanoparticles of NbON were synthesized from thermal decomposition of ammolysized NbOCl3. By using elemental analysis and neutron diffraction, this compound was determined to be NbO1.3(1)N0.7(1) instead of NbON. Samples exhibiting the morphologically feature as 3-5 nm nano-sized particles were observed. Our study indicates that NbO1.3(1)N0.7(1) coated with 4.6 weight-% of carbon has much more stable and reversible cycling performance than the pure sample. When the cutoff potential was set at 0.05V and 1V, the measured capacities reached 500 Ah/kg and 100Ah/kg during the first discharge and then stabilized at 250 Ah/kg and 80 Ah/kg in subsequent cycling, respectively.

5:30 **PANEL DISCUSSION: Application Driven Innovation - a Key to Lithium Ion Batteries Commercial Success**

6:00 *End of Day One*

Tuesday, November 8, 2011

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

9:00 **Hybrid Si/Ge-Carbon Nanotube Anodes for Lithium Ion Batteries**

Brian J. Landi, PhD, Assistant Professor, Microsystems Engineering, Rochester Institute of Technology

Free-standing carbon nanotube (CNT) electrodes are shown to effectively support ultra-high capacity materials like Si and Ge for anodes in lithium ion batteries. The research has demonstrated both Si and Ge-CNT anodes with high reversible anode capacity (>1000 mAh/g), and using select metallization show excellent power density and modest cycling performance. The impact of this research is electrode technologies capable of enhancing today's battery energy density to exceed 300 Wh/kg.

9:30 **Lithium Intercalation in Nanoscale Electrode Materials: Silicon Nanostructures**

Corey T. Love, PhD, Materials Engineer, U.S. Naval Research Laboratory

Many intercalation materials can only achieve high specific capacity at the nanoscale. Using nanostructured silicon as a model anode material, we show the dependence of lithium capacity on morphology and structure. The electrochemical performance of several silicon nanostructures (nanoparticles, nanowires, nanoporous architecture) will be presented. We are working to identify and control the mechanical and electronic stability of nanostructured silicon for improved cycle life performance. The ability of nanostructures to maintain stability compared to bulk materials will also be discussed.

10:00 **Can Si Nano-Materials Provide High Energy Density in Li-Ion Cells without Cycle Life Compromise?**

Yimin Zhu, PhD, Director of Battery and Fuel Cell, Nanosys, Inc

Many attempts have been made to utilize silicon's large storage capacity for lithium in practical Li-ion battery applications. Up to now, no efficient, durable and cost effective solution has been presented. Nanosys' method of architecting novel materials for particular technical applications from the bottom up not only results in the desired specific materials properties but also allows for designing its materials to fit existing processes and manufacturing equipment. This presentation will show how, through the use of architected silicon nano-materials, the cell energy density can be dramatically increased simply by replacing graphite in the anode manufacturing process with our cost-effective Si composite while achieving high cycle efficiency and cycle life.

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

11:00 **State of Health Assessment of Lithium Batteries from Thermodynamics Studies**

Rachid Yazami, PhD, Professor, Principal Scientist, School of Materials Science and Engineering, Nanyang Technological University, Singapore

We have developed a new technique based on thermodynamics measurements performed on lithium half- and full-cells aimed at assessing the state of health (SOH) of electrode materials and of full batteries. Entropy, enthalpy and free energy state functions are determined by following the temperature dependence of OCV at different states of charge of the cell. Thermodynamics data are correlated with characteristic phase transitions taking place in anode and cathode materials, which are found to be SOH dependant. In the presentation we will show thermodynamics data collected with anode and cathode materials at different SOH. We will discuss on how the SOH assessment can be used to improve the battery safety and may be to proactively prevent battery thermal events.

11:30 Lowering Cost with Water: Green Manufacturing for Li-Ion Batteries

*Jacob Muthu, PhD, Vice President, Research & Development, International Battery**

The large scale adoption of Li-ion batteries is limited due to cost and safety. Safety issues may be addressed by selecting the right combinations of chemistries. In this paper, we present results for large format Li-ion batteries manufactured using water based processes and how it reduces cost without affecting the cell performance as compared to traditional solvent based Li-ion battery manufacturing. Results focus on safe and environmentally friendly LiFePO4 chemistry.
**In collaboration with: M.Mamari, C.Crane, H.Georges*

12:00 Factors of Carbon Coating Affecting the Properties of LiFePO4/C Composites

George Ting-Kuo Fey, PhD, Dept of Chemical and Materials Engineering, National Central University, Taiwan, R.O.C.

In the search for new generation cathode materials for lithium-ion batteries, LiFePO4 stands out due to its low toxicity, low raw materials cost, and remarkable thermal stability. The main obstacle to commercial applications is the poor electrical conductivity of pristine LiFePO4, which can be overcome by effective carbon coating. The electrochemical performance of the LiFePO4 material is affected significantly by carbon coating. The following factors of carbon coating will be discussed in the presentation: 1) thickness, 2) particle size, 3) morphology, 4) surface area, 5) the ID/IG ratio, 6) uniformity, 7) particle shape. These factors can be evaluated by choosing proper carbon sources, using a suitable process, applying a ball milling technique, controlling calcination temperature, or optimizing particle size and surface area of carbon precursors.

12:30 *Lunch on Your Own*

2:00 A Multi-Scale Modeling Framework for Li-Ion Batteries

Partha P. Mukherjee, PhD, Staff Scientist, Oak Ridge National Laboratory

In this work, we present a multi-scale modeling approach for Li-ion batteries (LIB). The modeling framework consists of a volume averaged macroscopic model and a particle-resolved mesoscopic model. The macroscopic model relies on a rigorous volume averaging approach based on a single-domain formulation where complex geometries are incorporated with the numerical algorithms guaranteeing stability and convergence. In contrast to the multi-domain, pseudo-2D formulation with intermediate boundaries (anode/separator/cathode) based on the porous electrode theory, this unified formulation takes into account geometric multi-dimensionality (1D, 2D and 3D), electrode/electrolyte spatial arrangements and spatio-temporal variations in the physico-electrochemical properties. The mesoscopic model is based on fully resolved, statistically rigorous microstructure models of the battery electrodes using finite-volume technique with Cartesian cut-cell approach to account for the interfaces. We specifically study the solid state transport of Li in packed beds representative of typical electrodes and evaluate effective property and surface vs. bulk Li concentration relations. These scaled-up quantities are deployed in the macroscopic model described above. In this presentation, we describe the multi-scale modeling formalism with special emphasis on the influence of particle morphology (shape, size distribution) and particle-particle interactions on the transport (species, charge, and thermal) limitations and resulting performance implications in both the conventional and 3-D electrode architecture scenarios for the Li-ion battery.

2:30 Materials Design for the Lithium Conductive Material

Taku Onishi, PhD, Dept of Materials Chemistry, and The Center of Ultimate Technology for Nano-Electronics, Mie Univerisity, Japan

The perovskite-type transition metal compounds are well known to have the lithium ion conductivity. Under the operation temperature of lithium battery, the stable crystal structure is required for the high lithium ion conductivity. In this study, we theoretically designed the new lithium ion conductive perovskite with the thermally stable sturucture.

3:00 Improved Electrochemical Properties of LiNi0.5Mn1.5O4 Spinel Material by Surface Modification with AlPO4 Coating

Hyo-Ree Seo, Yong-Ju Jeong, & Keon Kim, Dept of Chemistry, Korea University, South Korea; and
Cheol-Woo Yi, Dept of Chemistry & Institute of Basic Science, Sungshin Women's University, South Korea

The attractive cathode material, LiNi0.5Mn1.5O4 for lithium ion batteries was synthesized and its surface was modified by coating AlPO4 by a sol-gel method. This research is aimed to figure out the effects of AlPO4 surface coating to pristine LiNi0.5Mn1.5O4. 1 and 3 wt.% AlPO4 was coated and we checked the AlPO4 particles were well distributed on the surface of LiNi0.5Mn1.5O4 its electrochemical performance was characterized by galvanostatic cycle tests between 3.0 and 4.95 V versus Li/Li+ at 0.5 C-rate. Among them, the 1 wt.% AlPO4 coated-LiNi0.5Mn1.5O4 showed enhanced electrochemical performances, especially improved cycle and lifetime capabilities because of the effective diminishing the contact of the electrodes and electrolyte, which give an effect of the formation of the SEI films on the surface of LiNi0.5Mn1.5O4. Also, the improved lithium-ion diffusion were demonstrated with the lower Rs and Rc by EIS. Besides, the

Conference Agenda

modified LiNi0.5Mn1.5O4 showed the stable reversibility at the high temperature, 55˚C. The improved kinetics and electrochemical properties are discussed in detail.

3:15 *Networking Refreshment Break, Exhibit/Poster Viewing*

3:45 **Surface Modification with LiCoO2 for Improving the Electrochemical Properties of LiNi0.5Mn1.5O4**

Eun-Ah Lee, Hee-Seon Choi, & Keon Kim, Dept of Chemistry, Korea University, South Korea; and

Cheol-Woo Yi, Dept of Chemistry & Institute of Basic Science, Sungshin Women's University, South Korea

Lithium-ion batteries are now considered to be the technology of choice for future hybrid electric and full electric vehicles. The LiMn2O4 spinel has been investigated as a 4 V cathode material for lithium-ion batteries. However, poor capacity retention due to the Jahn-Teller effect of Mn3+ hinders. A common way to overcome these defects is to replace Mn with another transition metal. Among them spinel LiNi0.5Mn1.5O4 material is one of the promising and attractive cathode materials because of its high voltage (4.7 V), acceptable stability, highest discharge capacity (146.7 mAh/g), and good cycling performance. But the capacity fading was occurred when the temperature increased. Therefore, we synthesized LiCoO2 which is the one of the low cost, environmentally friendly cathode material in the surface with different ratio of 2.5, 5.0 and 10 wt. % by sol-gel method. And we investigated their charge and discharge performances with 0.2 C-rate between 3.0 - 4.9 V cut-off regions at room temperature and evaluated temperature, 55˚C. The 2.5 wt. % LiCoO2-added LiNi0.5Mn1.5O4 showed the best capacity and cycle abilities with 136 mAh/g.

4:00 **Lithium Batteries as Replacements for Lead Acid Applications**

Jim Hodge, PhD, Chief Technical Officer, K2 Energy Solutions, Inc.

The fundamental voltage of the lithium iron phosphate (LFP) chemistry enables the manufacture of batteries with voltages closely matching those of lead-acid batteries. Consequently, LFP batteries can be fabricated that are "drop-in" replacements for lead-acid for a wide variety of applications. These LFP batteries offer significant advantages over lead acid in terms of both cycle life and capacity.

4:30 **Exhibitors and Sponsors Showcase Presentations**

5:00 **Selected Oral Poster Highlights and Open Discussion**

5:30 *Concluding Remarks, End of Conference*

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Advancements in Systems Design, Integration & Testing for Safety & Reliabilty

Widely publicized safety incidents and recalls of lithium-ion batteries have raised legitimate concerns regarding lithium-ion battery safety. Battery Safety 2011 is conveniently timed with Lithium Battery Power 2011 and will address these concerns by exploring the following topics:

- Application specific battery safety issues affecting battery performance
- Major battery degradation and reliability factors
- Battery management systems
- Commercial cells evaluation and failure analysis
- Advances in testing techniques and protocols
- High throughput testing, automation and modeling for better safety
- Standardization & Regulatory issues

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Wednesday, November 9, 2011

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

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

9:00 **Lithium-Ion Battery Safety: Issues and Solutions**

Ralph J. Brodd, PhD, Director, Kentucky-Argonne Battery Manufacturing Research and Development Center

An overview of the safety issues will be presented from the point of view of the chemistry, manufacturing and application in electronic as well as transportation applications. The major cause of safety incidents in batteries for electronic applications has been related to manufacturing defects in the materials and cell assembly. These are of the order of one incident in 5 million cells. New applications for electric and hybrid vehicles require a significant improvement in cell reliability by an order of magnitude over present practice as well as a means to isolate problem cells from the main stream in a battery pack. These and other issues to mediate problem cells will be discussed

9:30 **Breakthrough in Large-Format Li-ion Battery Safety through Computer Simulation**

Chao-Yang Wang, PhD, Distinguished Professor of Mechanical, Chemical, & Materials Science and Engineering, Director, Electrochemical Engine Center (ECEC), Co-Director, Battery & Energy Storage Technology (BEST) Center, The Pennsylvania State University

Currently whether or not a battery is safe is assessed by a set of abuse tests that are not as sensitive and accurate as they should be. We at Penn State ECEC, working with engineers at EC POWER as part of the DOE CAEBAT program, have developed computer models and tools to simulate processes of nail penetration, internal shorting, and thermal runaway in automotive Li-ion batteries with complex geometries. We shall show effects of nail diameter and penetration speed during partial or full penetration, location of shorting, and cell capacity on safety characteristics. We highlight fundamental insight into safety events and propose safety-enhancement strategies. Combined with experimental validation, computer simulation offers a possibility to design inherently safe batteries for automotive applications.

10:00 **Abuse Tolerant Lithium-Ion Cells for Transportation Applications**

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

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

11:00 **Safe Li-Ion Technologies for Transportation and Energy Storage**

Karim Zaghib, PhD, Team Leader - Li-Ion Battery, Energy Storage and Conversion, Hydro-Québec Research Institute (IREQ), Canada

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

11:30 **Safety of Lithium-Ion PHEV Cells: Cylindrical versus Prismatic**

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

The occurrence of safety-related field-failures has prompted large-scale recalls of lithium-ion battery packs in consumer applications. The severity of field-failures is forcing the industry and the research community to adopt new approaches to tackle safety. That is especially the case when even larger lithium-ion cells are being considered for transportation applications. For PHEV scale cells, there has been considerable debate regarding the relative merits of cylindrical versus prismatic (and pouch) cells with regard to safety, as well as performance. We have used simulations, supported by experiments, to help set a quantitative framework for consideration of relative safety of large format cylindrical and prismatic cells, and to help understand the conditions that favor thermal runaway following development of an internal short, the latter being the most frequent cause of safety incidents. Results for the relative safety of cylindrical and prismatic 33 Ah cells are presented and described. We also discuss the implications of these results for materials selection and consideration of various cell designs.

12:00 **Working Toward a Fail-Safe Design for Large Capacity Lithium-Ion Batteries**

Gi-Heon Kim, PhD, Kandler Smith, PhD, and Ahmad Pesaran, PhD, National Renewable Energy Laboratory

Lithium-ion batteries (LIBs) are believed to be a promising candidate for electric energy storage of electric drive vehicles due to their high power and energy density. However, violent incidents reported for this technology and consequent safety concern are the major obstacle for fast market acceptance of LIB powered electric vehicles. High temperature triggers exothermic decompositions of LIB components often resulting in violent failure of the system, known as thermal runaway of LIBs. Mature small capacity LIBs, used in applications such as consumer electronics and power tools, typically incorporate multiple layers of safety incident mitigation methods. LIBs for vehicle applications should be much larger in capacity and physical size than those for consumer electronics. Scaling-up of LIBs dramatically changes the responses of LIB system under safety incidents. Consequently, protection/mitigation technologies for small cell system against safety incidents, such as positive temperature coefficient (PTC), current interrupt device (CID), and shutdown separator, do not work properly with large format LIB cells. This paper will introduce NREL's recent model/experimental investigation for a safety enhanced large battery design with features enabling early fault detection and electrical isolation of a fault.

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

2:00 Navy High Energy Power Source Platform Integration - Recent Initiatives and Results

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

The Navy will be using advanced power sources in various payloads and platforms. These advanced power sources provide higher energy density and greater power density than traditional sources (e.g. Pb-Acid batteries) and the capability benefits come with definable hazards and potential risks. The Navy has undertaken to establish a broader aspect of hazard assessment based on MIL-STD-882 for electrochemical power sources (batteries, capacitors, fuel cells) and hybrid systems based on these components. We will describe the current instructions and guidance, results from recent characterization tests, and general findings and explicabilities to portable and embedded systems. **In collaboration with: J.Schwartz, D.Fuentevilla, E.Rule, E.Shields*

2:30 Lithium Ion Failure Rates and Fire Protection Considerations

Celina J. Mikolajczak, PE, Senior Managing Engineer, Exponent

Lithium-ion battery technology has become endemic to the consumer electronics industry and is finding new applications in industrial and transportation sectors. As lithium-ion batteries get larger and are used to store greater amounts of energy, there is interest in assessing the risk of failure, developing strategies for failure mitigation. We will discuss failure modes and failure rates associated with un-used lithium-ion batteries (i.e. new batteries in storage, or in transit to end users) compared to failure modes and failure rates of batteries that have been placed into service. Then we will discuss some considerations for fire protection under these varying scenarios.

3:00 Challenges for Safety Standards for Lithium-Ion Cells

Mahmood Tabaddor, PhD, Research Manager, Predictive Modeling and Risk Analysis Group, Corporate Research, Underwriters Laboratories Inc.

Safety Standards help promote the safe commercialization of products. However, in some cases such as with lithium-ion cells, when the technology is developing so fast and an understanding of potential failure modes is still an active area of research, there is a tremendous challenge to updating the safety standard. Tests that may show promise in a laboratory setting providing battery designers and researchers insights may not translate well as a new test for a safety standard. This presentation will describe the search for a new test method for battery safety standards to help address field failures of lithium-ion cells attributed to thermal runaway due to internal short circuit.

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

4:00 Active Thermal Management of Lithium Ion Batteries Using Flexible Graphite Heat Spreaders

Jonathan A. Taylor, R&D Engineer, Advanced Energy, GrafTech International

Thermal management systems promote excellent performance, durability and safety in large lithium ion batteries, but often add weight, volume, complexity, parasitic power consumption and cost to the system. Flexible graphite has a unique combination of properties that enable compact, lightweight, thermal solutions. In this paper, a flexible graphite-based active thermal management solution for prismatic lithium ion batteries is presented. The inventive design effectively manages cell temperatures despite being more lightweight and compact than conventional liquid-cooled systems.

4:30 Implications of Cell to Cell Manufacturing Variations on Potential Risk of Safety of a Lithium ion Battery

Shanthi Korutla, PhD, Director, Battery Cells & Advance Product Development, International Battery, Inc.

Safety concerns of lithium ion batteries are becoming more of a focus of the public's attention. This has resulted in the ever increasing commercial use of $LiFePO_4$ due to its intrinsic safety and chemical stability as cathode materials. Large format Li ion cells manufactured with aqueous processing of $LiFePO_4$-based electrodes with a combination of water-soluble binders exhibited excellent tolerance under extremely abusive conditions such as induced short circuit, over discharge, over charge, nail penetration crush test, etc. that add to its superior electrochemical performance in normal use. In an increasing number of definitive parameters for cell selection are being used to build more effective Li ion battery pack, traditional parameters such as cell capacity, resistance and self-discharge etc. measurements do not provide enough information for optimum cell selection, particularly for large format cells that must meet high standards of abuse tolerance in addition to superior in electrochemical performance in a normal operation. Electrode and cell manufacturing process parameters plays an important role as well for safety risks.

The paper addresses how the impact of cell to cell variation in a battery system affects both electrochemical performance and abuse tolerance behavior.

5:00 **Failure Investigation of Li-Ion Batteries**

Jian Xie, PhD, Professor of Mechanical Engineering, Lugar Center for Renewable Energy, Indiana University - Purdue University Indianapolis (IUPUI); and

Yang Ren, PhD, X-Ray Science Division, Argonne National Laboratory

Lithium ion batteries (LIBs) have the highest specific energy and energy density among the different battery technologies. This high specific energy and energy density are desired for many applications, but are the potential causes of safety incidents, which could cause detrimental damage to valuable property and could even cost human lives. Therefore, the safety of LIBs is of a great importance to their application in portable electronics, electric and hybrid electric vehicles, and military devices and systems. To maintain safe operation of a LIB cell, it is necessary to monitor the state of health of that cell. In order to do so, LIB failure needs to be comprehensively investigated including failure modes, failure causes, signs of early failure, detection methods to catch early failure signs, etc. Then, a system should be developed to monitor the LIB state of health. We have formed a team of government, academia, and industry professionals to investigate the failure of LIBs. A comprehensive and systematic approach has been taken to study the failure mechanism. A synchrotron high-energy X-ray coupled with electrochemical testing was used to study the in situ structural changes of the electrode materials during the charge/discharge cycle. The anode MCMB was found to have a new phase of Li and C compounds formed after overcharge as well as a possible Li deposition. The in situ structural changes of the cathode were also studied. When over-discharging, the corrosion of the Cu current collector was found to be the major cause of LIB failure. The failure mechanism of $LiFePO_4$ cell under overcharge and over discharge conditions have been elucidated from our experimental investigation. The signatures of failure have been identified experimentally. The model/algorithm has been developed for early warning detection. A detection system which can detect the early signs of failure has been developed. This work was supported by US Navy Warfare Center.

5:30 **MODERATED DISCUSSION:**

Battery Safety in Perspective: Real World Assessment of the Most Significant Challenges Facing Advanced Li-Ion Cells Commercialization

6:00 *End of Day One*

Thursday, November 10, 2011

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

9:00 **Thermally Stable Electrolyte for Li-Ion Cells**

Ganesan Nagasubramanian, PhD, Sandia National Laboratories

Thermal instability of Li-ion cells is a key concern that delays their adoption for transportation applications. The pervasive thermal instability mainly stems from the organic electrolytes and that needs to be eliminated for wide-spread use. Several different approaches including addition of fire retardants, ionic liquids, fluoro compounds, etc. have been made to mitigate this propensity, however, only with a limited success. In this talk our results on Hydro Fluoro Ethers to eliminating this hazard will be discussed.

9:30 **Diagnostic Tools Development for Understanding and Monitoring Overcharge**

Corey T. Love, PhD, Materials Engineer, U.S. Naval Research Laboratory

Safe operation of lithium-ion batteries is significantly influenced by charge/discharge voltage boundaries and the stability of electrode/electrolyte interfaces. Three tools are being developed to detect and understand the detrimental effects of overcharging at the electrode and cell level. First, an *in-situ* impedance method shows significant changes in a commercial lithium-ion polymer cell charged above 4.4 V. Second, *in-situ* X-ray absorption spectroscopy detects structural changes and performance losses within $LiFePO_4$ after repeated cycling. Lastly, we probe the solid electrolyte interface in overcharged electrodes using the surface sensitive "Δ" XANES technique. Results will be presented and discussed as part of a broader effort towards the development of diagnostic tools for lithium-ion batteries.

10:00 **Characterization of Battery Materials: A Battery Safety Perspective**

Sanjay Patel, PhD, Director of Analytical Services at Evan Analytical Group (EAG)

A good understanding of the consistency of materials entering the battery manufacturing supply chain is essential, from both a regulatory, scientific and safety perspective. A number of different analytical methods are available, many currently in use, to the battery industry for materials characterization for various purposes. The long-term life cycle and performance of a battery pack can potentially be affected by the presence of unwanted impurities in electrode materials. Variation in electrode composition can result in changes to individual cell performance and affect the stability of the entire battery system. With recent demands from the automobile industry for improvements in battery performance together with stringent safety requirements, adequate understanding and successful monitoring of battery raw materials has become important across the industry. This presentation will review a number of different analytical methods, focusing on those that are well suited to the battery industry for monitoring raw materials for production control. Methods are available that simultaneously allow the measurement of a wide range of impurity levels, thus allowing manufacturers or other end users to determine the consistency of their supply chain and identify changes in raw material quality from their supplier or other changes caused at a particular manufacturing stage.

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

11:00 Simulated Internal Short Test Work from NASA and Underwriters Laboratories

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

NASA has collaborated with UL to define a standard for the simulation of internal short tests. The initial set of tests included testing a set of cells of an 18650 Li-ion cylindrical cell design using a crush test method and analysis of the indentation and cells using CT scan techniques as well as destructive physical analysis. The standard developed will include recommendations on crush rod diameter, rate of displacement of the crush rod, voltage drop limit conditions, state-of-charge of the cells, orientation of the cells, etc.

11:30 Abuse Testing of Lithium Ion Cells: Internal Short Circuit, Accelerated Rate Calorimetry and Nail Penetration in Large Cells (1 - 20 Ah)

Kirby W. Beard, COO, and Ann Edwards, Porous Power Technologies; and

David Wood, Wei Cai, Jianlin Li, Hsin Wang, Oak Ridge National Laboratory

Oak Ridge National Laboratory (ORNL) and Porous Power Technologies (PPT) are developing and testing large C/$LiCoO_2$ cells with PPT's advanced separators. Temperature resistant separators with non-woven web reinforcements and high levels of ceramic filler (to 90% wt.) have survived 220 deg. C temperatures and various abuse tests. Internal short circuit testing, using a new ORNL test protocol, has shown survivability under overcharge/compression testing. Additional destructive over-heating (accelerated rate calorimetry) and nail puncture safety tests were also conducted.

12:00 Safety Testing and Live Video of Large Li-Ion Batteries

Jasbir Singh, PhD, Managing Director, HEL Ltd, United Kingdom

Reliable safety testing of larger batteries and battery packs requires new devices that can handle the potential energy release but also provide the necessary precision to allow reliable prediction of performance. Also, many current testing protocols call for video evidence to accompany the traditional data as photographic evidence gives much needed extra insight. Traditional "ARC" type adiabatic calorimeters are not able to meet these demanding needs and this presentation will show data and videos from a custom designed Battery Testing Calorimeter to provide much needed expansion of "ARC" type data including the use of integrated “cyclers” to evaluate charging and discharging limits.

12:30 *Lunch on Your Own*

2:00 The BMS in Focus- Safety, Testing and Operational For Mobile and Fixed Installations

Ken Chisholm, Global Business Director, Vecture, Inc., Canada

The Battery Management System (BMS) is a critical issue in the safe and reliable operation of lithium re-chargeable chemistries. With smaller battery packs the BMS system is a significant cost adder whilst in larger systems such as GRID systems the BMS needs to manage multiple strings and many cells in series, interacting with the main control system, providing data and control signals. Testing the BMS and the battery packs has safety, reliability and cost implications. The test requirements for smaller, and usually much higher volumes, are very different from the test and integration requirements for large format systems. (i) Considering battery management systems (BMS), from small to large format with safety and performance in focus; (ii) Advances in testing techniques: (a) testing the one shot secondary system, (b) large format systems where operator safety and system integration are key requirements; (iii) Contribution of the BMS in data collection for predictive failure analysis and operational profiling; (iv) Mean time to repair (MTTR) in large format modular systems; and (v) High throughput test systems for the BMS and battery pack.

2:30 Battery Management Systems for Industrial Applications

Ivan Loncarevic, CEO, CTO & Founder, Lithium Balance A/S, Denmark

The adoption of Li ion battery technology to power industrial machines has driven the need for appropriate battery management and suitable Li Ion cells. The term industrial application is this context refers to the following areas: materials handling; cleaning machines; lifts and aerial devices; utility vehicles. These applications characterize themselves by being typically below 120 volts and utilizing relatively large capacity, low cost batteries often operating in harsh environments. Acute price sensitivity is another characteristic of this market. The role of the battery management in this environment is to provide safe battery operation, control of switching circuitry, SoC estimation and charger control. This differs from an automotive application where typically a CAN enabled vehicle control unit would be present to provide the high level system intelligence and logic. The BMS takes on this role providing direct control of the BDU (battery disconnect unit). The safety logic and providing information to the load,

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such as CAN messages outlining the recommended allowable discharge rate and regeneration rates from and to the battery at any given time may be required in some applications, in others where there is no CAN bus present the system still needs to provide SoC information, signaling and control to external devices such as chargers.

3:00 *Networking Refreshment Break, Exhibit/Poster Viewing*

3:30 **How to Test & Certify Electric Vehicle Supply Equipment (EVESE) for North America**

Tom O'Hara, Intertek

You've designed your EV Supply Equipment (including charging stations and ancillary components) in-line with the regulatory standards that govern your product. Now you have a responsibility, in some cases mandatory, to have your product tested and certified ("listed") by an independent body recognized for their competency in electrical or mechanical safety. This allows you to sell your products in North America, and allows installers, retailers and inspectors to feel comfortable about your product's compliance to industry accepted safety standards. In the case of EV charging systems, Article 625 of the US National Electric Code (NEC) indicates that "all electrical materials, devices, fittings and associated equipment shall be listed or labeled", specifically Paragraph 625.1 Scope – The provisions of this article cover the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive or inductive means, and the installation of equipment and devices related to electric vehicle charging. Ultimately the local AHJs – "Authority Having Jurisdiction" (often electrical code inspectors) have the final say in the acceptance of equipment and electrical installations. And the NEC tells the AHJ that one way of knowing a piece of equipment is okay, is to look for the "listing mark" of an approved lab.

4:00 **Collection of Spent Lithium Batteries in Europe: Hazard and Safety Issues**

Jean-Pol Wiaux, PhD, Director General, RECHARGE aisbl, The European Association of the Advanced Rechargeable Batteries Industry, Belgium

A review of the European collection schemes of spent batteries will be presented with a focus on spent lithium batteries. An analysis of the transport regulation and safety measures taken to transport spent lithium batteries will be presented considering the collection of mixed spent batteries. A report on incidents recorded for several years in Europe will be discussed and best practice recommendations in transport as well as emergency responses guidance will also be discussed.

4:30 **Exhibitors and Sponsors Showcase Presentations**

5:00 **Selected Oral Poster Highlights and Open Discussion & Concluding Remarks**

5:30 *Concluding Remarks, End of Conference*

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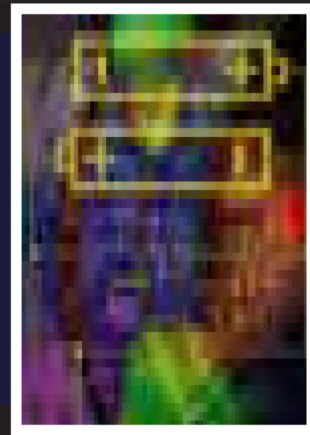

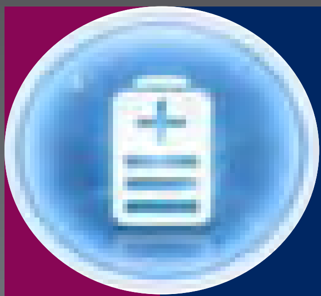

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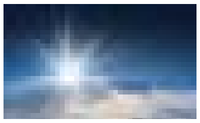

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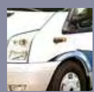

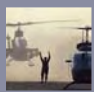

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- Customized basic name badge lanyards with your company logo included

Conference Notepad & Pens — Cost: $1,500

Benefits:

- 8.5” x 11” Black and white advertisement inserted into the conference documentation binder
- Customized basic notepads and pens with your company logo included

On-site Materials Display — Cost: $329

Benefits:

- Display your materials prominently at the conference

Documentation Binder Advertising — 4-Color: $399, B&W: $299

Benefits:

- 8.5” x 11” black and white or 4-color advertisement inserted into the conference documentation binder

Website Banner Advertising — Cost per click: $30.00 (billed monthly)

Benefits:

- (1) 468 pixel x 60 pixel banner ad placed prominently on knowledgefoundation.com

for complete details contact Craig Wohlers at (617) 232 7400 ext. 205
or email at cwohlers@knowledgefoundation.com

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Advertising Opportunities

Conference Tote Bags

Cost: $3,000

Benefits:

- Your company logo prominently displayed to all conference delegates on customized tote bags given to each attendee
- 8.5” x 11” Black and white advertisement inserted into the conference documentation binder
- Customized basic tote bags with your company logo included

Wireless Internet Access

Cost: $3,000

Benefits:

- Your company logo prominently displayed as the sponsor of wireless internet access at the conference for the duration of the conference
- 8.5” x 11” Black and white advertisement inserted into the conference documentation binder

CD Rom Label Logo Placement

Cost: $3,000

Benefits:

- Your company logo prominently displayed to all conference delegates on customized 4-color Cd Rom of the conference documentation
- 8.5” x 11” Black and white advertisement inserted into the conference documentation binder

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Registration Form

Event ____

Name ____

Title ____

Company ____

Address ____

City State Zip _______________________________________

Phone_____________________________Fax _______________

E-mail ____

Please sign me up for:

- ❑ 4 DAY (Lithium, Battery Safety & Partnering Summit)
  10' x 10' Exhibit Booth Space *$3,999.00*
  SAVE $600
- ❑ 2 DAY (Lithium Battery Power Only)
  10' x 10' Exhibit Booth Space *$2,299.00*
- ❑ 2 DAY (Battery Safety & Partnering Summit)
  10' x 10' Exhibit Booth Space *$2,299.00*
- ❑ Additional Exhibit-Only Booth Attendant *$149.00*
- ❑ Gold Sponsor *$10,000.00*
- ❑ Silver Sponsor *$5,000.00*
- ❑ Workshop Sponsor *$5,000.00*
- ❑ Luncheon Sponsor *$3,500.00*
- ❑ Cocktail Reception Sponsor *$3,500.00*
- ❑ Conference Workshop Sponsor *$5,000.00*
- ❑ Hospitality Suite *$4,399.00*
- ❑ Tote Bag Sponsor *$3,000.00*
- ❑ Cd Rom Label Advertising $3,000.00
- ❑ Wireless Internet Access $3,000.00
- ❑ Name Badge Lanyard Sponsor *$2,000.00*
- ❑ Product Showcase Presentation *$1,299.00*
- ❑ Notepad & Pen Sponsor *$1,500.00*
- ❑ On-site Materials Display *$329.00*
- ❑ Black & White Doc Binder Ad *$299.00*
- ❑ Additional Exhibit-Only Booth Attendant *$149.00*
- ❑ Full Color Doc Binder Ad *$399.00*
- ❑ Web Banner Advertising *$30 per click (billed monthly)*

FAX, MAIL, CALL, E-MAIL TO:
The Knowledge Foundation
18 Webster Street
Brookline, MA 02446 USA
Tel: (617) 232-7400 ext. 210
Fax: (617) 232-9171
E-Mail:
cwohlers@knowledgefoundation.com

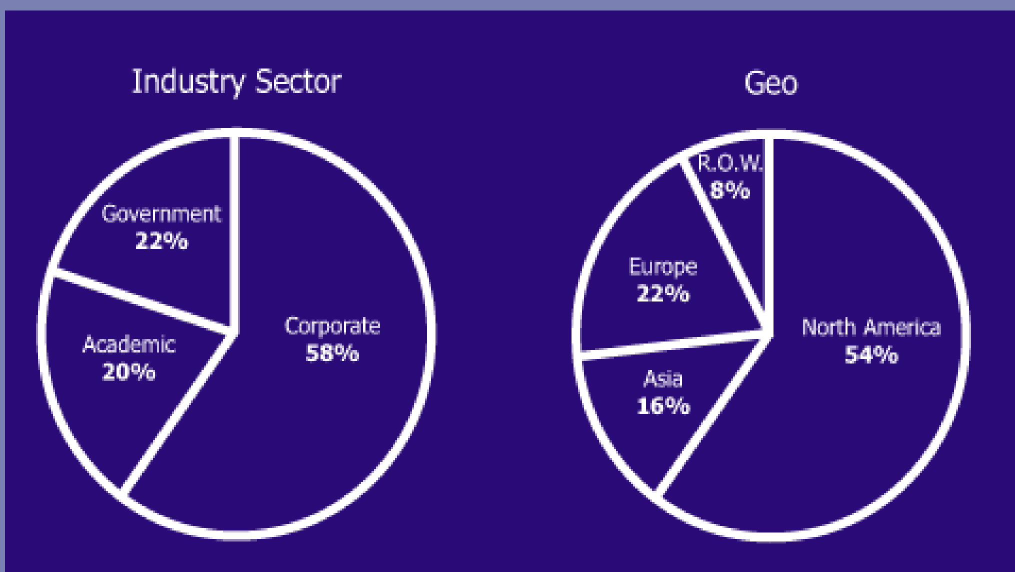
Method of Payment

❑ Master Card ❑ Visa ❑ American Express

Card Number:____ exp.________________1

Attendee Demographics

Industry Sector & Geographical Breakdown of Our Conference Delegates



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Phone: (617) 232 7400 Fax: (617) 232 9171

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Past Attending Organizations

Here are some of the organizations who have attended our Lithium Battery and Battery Safety Conferences in the past two years

Organization	Title
Arkema Inc.	Market Manager
A.T. Wall	Technical Sales
A&D Technology, Inc.	Engineer
A123Systems	Director of Product Marketing
A123Systems	Director, R&D
A123Systems	Vice President of Business Dev.
AA Portable Power/Batteryspace	Marketing Manager
Acme Electric Corp	
ActaCell, Inc.	CEO
Acumentrics	Director
Adhesives Research	Vice President & Director
Adhesives Research	Vice President, Technology
Advance Research Chemicals, Inc.	Director of Manufacturing
Aerovironment	Sales Manager
AltairNano, Inc.	Director R&D
American BDG	
Amprius	Director, Battery Engineering
Amtek Research International	Electrochemist
Analog Devices	Application Engineer
Apple Inc.	Product Safety Engineer
Applied Materials	Senior Manager
Applied Materials - ATK	Director of Technology
Argonne National Laboratory	Chemist
Argonne National Laboratory	Principal Electrical Engineer
Argonne National Laboratory	Technology Specialist
Arkwright Advanced Coating Inc.	
Atmel Corp.	Director
BAE Systems	Electronics Engineer
Bar-Ilan University	Professor
BASF	Senior Manager
BASF Corporation	Global Product Technology Manager
BASF SE	
Bathium Canada Inc.	Vice President Technology
Battery Safety Consulting, Inc.	President
Battery Solutions	Executive Account Manager
Bluefin Robotics Corporation	Director of Power Systems
Bose Corporation	Senior Scientist
Boston-Power Inc	CTO
Brady Corporation	Sr. Process Engineer
Brady Worldwide	Sales Manager
Brookhaven National Laboratory	Scientist
BTU International	Director of Research
Bureau van Deutekom	
Cabot Corporation	Senior Scientist
California Institute of Technology	Director

Organization	Title
Carnegie Mellon University	Professor
CD-adapco	US Trade Show Coordinator
CD-adapco	Automotive Technology Director
CD-adapco	Director
CD-adapco	Manager, Advanced Methods
CEA - LITEN	
Celgard, LLC	Americas Sales Manager
Central Electrochemical Research Inst.	Scientist
Central Laboratory of Batteries and Cells	Professor
CFX Battery Inc.	CTO
CHEMETALL GMBH	
Chemi-Con Laboratory	Laboratory Director
China BAK Battery, Inc.	Vice President
Chroma ATE Inc.	Director of Business Development
Chroma ATE Inc.	Product Marketing Director
Chubb & Sons	Vice President
Chung Yuan Christian University	Professor
Cincinnati Sub-Zero	Marketing Mgr
Coatema Coating Machinery GmbH	Vice President
Cognex	Market Development Manager
Columbia Sportswear	Electronics Integration Specialist
Concurrent Technologies Corporation	Electrical Engineer
ConocoPhillips Company	Product Manager
Corning Incorporated	Manager, Technology Assessment
Detorit Testing Laboratory	Battery Lab Department Manager
Direct Vapor Technologies International	Research Scientist
DNP Corp. USA	Manager
Dow Chemical Company	Principal Research Scientist
Dow Chemical Company	Project Leader
Dow Corning	Leader
Dow Kokam	Chief Technology Officer
Dow Kokam	R&D Director
DSTL	Power Source Scientist
Duracell	Principal Engineer
E-KEM Sciences	Chief Technology Officer
E-ONE MOLI ENERGY LTD	Director of Quality
EaglePicher	Program Manager
EaglePicher Medical Power	Scientist
EaglePicher Technologies	Director of R&D
EEtrex Incorporated	Chief Technology Officer
EIC Labs	Director of Battery Engineering
Electric Boat Drives LLC	
Electrochem Solutions	Compliance Engineer
Electrovaya Inc.	Chairman, President & CEO
EMD Chemicals	

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Past Attending Organizations

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Organization	Title
Ener1, Inc. / NanoEner, Inc.	Head of Testing Group
Energizer	Information Assistant
Energizer Holdings	Senior Information Specialist
Enersys/American BDG	
Enovate	Chief Technology Officer
Entegris	Application Engineer
Entegris	Applications Specialist
Entegris	Director of Battery Development
Epyon BV	Innovation Manager
ETH Zurich	
ETRI	Senior Researcher
Evans Analytical Group	
Excellatron Solid State	COO
Excellatron Solid State	President
EXOPACK ADVANCED COATINGS	Business Development Manager
Exponent	Senior Scientist
Exponent	Manager, Electrical Practice
Exponent	Senior Managing Engineer
Exponent	Senior Managing Scientist
FedEx	Manager
Freudenberg - NOK	Engineering Manager
Fronius International GmbH	Safety Engineer
General Atomics	Engineer
General Dynamics C4 Systems	Senior Systems Engineer
GN ReSound A/S	Senior Engineer
GN Netcom	
Greatbatch	Senior Product Line Manager
Greatbatch	Director, Battery Research
Groz-Beckert KG	
HEL Inc.	President
Henkel Corporation	Marketing
Hibar Systems	Technical Sales
Hirose Paper Mfg. Co., Ltd.	Director, Adv.Functional Materials
Hirose Paper Mfg. Co., Ltd.	Research Engineer
Hirose Paper Mfg. Co., Ltd.	Director, Global Business Development
Hitachi America, Ltd.	Sourcing Engineer
Hollingsworth & Vose	Scientist
Hollingsworth & Vose	Manager, New Market Development
Honda R&D Americas, Inc	Engineer
Honda Research Institute USA Inc.	Principal
HVR Advanced Power Components	Engineer
Hyperion Catalysis International	Marketing Director
Idaho National Laboratory	Principal Investigator
Imara Corp.	Marketing Assistant
Imara Corp.	VP, Technology

Organization	Title
IMEC Micropower	
Inabata America Corporation	Sales
INERIS	Engineer
Infinite Power Solutions	CTO
International Battery	Research and Development
Intertek	Consumer Battery Specialist
ITECH	Technical Marketing Manager
JCS	Manager, Systems Integration
Jet Propulsion Laboratory/CalTech	Principal Member Technical Staff
Johnson Controls	Director
Johnson Controls	Electrochemist
Johnson Controls	Principal Engineer
Johnson Matthey	
KAIST	
Kangwon National University	Professor
KEMA	
Lab for Physical Sciences	Senior Chemist
LaunchPoint Energy and Power (LEAP)	President and CTO
Leclanché Lithium GmbH	Chief Executive Officer and Director
Lenovo	
Lithchem Energy	Director, Li-Batteries R&D
Lubrizol	
Maccor, Inc.	Sales Engineer
Maccor, Inc.	VP Sales and Marketing
Magna eCar Systems	Testing Supervisor
Magna International	
Manz	Business Development Manager
Manz Automation, Inc.	Vice President
Massachusetts Institute of Technology	
Maxwell Technologies	VP/ CTO
MBARI	AUV Supervisor
MBARI	Electrical Engineer
MEGTEC Systems Inc.	Marketing Manager
Miele & Cie. KG	
Mobile Power Solutions	President
Mobius Power, Inc.	Battery Scientist
Moog, Inc.	Project Eng. Associate
Motorola Mobile Devices	Staff Scientist
MTI Corporation	Marketing Manager
Murdoch University	Senior Research Fellow
Nanosys Inc.	Vice President of Engineering
Nanosys, Inc.	Director of Battery & Fuel Cells
NASA Johnson Space Center	Senior Scientist
National Renewable Energy Laboratory	Senior Research Engineer
National Research Council of Canada	

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Knowledge Foundation
Technology Commercialization Alliance

Lithium Battery Power
7th Annual International Conference
November 7-8, 2011 • Las Vegas, NV USA

Battery Safety 2011
November 9-10, 2011
Las Vegas, NV USA
Advancements in Systems Design, Integration & Testing for Safety & Reliability

Past Attending Organizations

Here are some of the organizations who have attended our Lithium Battery and Battery Safety Conferences in the past two years

Organization	Title
Naval Surface Warfare Center Carderock	Group Leader and Senior Technologist
Naval Undersea Warfare Center	Engineer
Netzsch Instruments North America	Regional Sales Manager
Nexeon Ltd.	
Nexergy	
NexTech Materials, Ltd.	Director, Commercial Services
Nissan Technical Center N.A.	Principal Engineer
Northeastern University	Professor
NOVOLYTE TECHNOLOGIES	
NSWC Crane	Engineer
Oak-Mitsui	VP of Strategic Technology
OMG	Manager, New Business & Applications
OMG AMERICAS INC	Sales Manager Americas
Orbotech	
P3 Ingenieurgesellschaft	
Pacific Northwest National Laboratory	Chief Scientist, Battery Technology
Panasonic	Staff Engineer, OEM Battery Group
Panasonic Corporation	Engineer
Panasonic Corporation	Staff Engineer
Panasonic Energy Solutions Lab	Senior Manager
PCTEST	CTO
PEC Corp.	Senior Sales Engineer
Petratec	
Phillips Plastics	Communications Manager
Phillips Plastics	R&D Manager
Pike Research	Senior Analyst
PMI	
PolyPlus Battery Company	Chief Technical Officer & VP
Portable Power Consultants	CEO
Progressive Technologies, Inc.	
Purdue Univ Indianapolis	Professor
RAYOVAC CORP	Director of Contract Research
Renata AG	Head R&D
Research In Motion	Head of New Energy Technologies
Robert Bosch LLC	
Rutgers University	Professor, Director
RWTH Aachen	Dipl.-Ing
SAFT America	Mechanical Engineer
SAFT America	Mechanical Engineer Manager
Samsung SDI	
Samsung SDI America	Manager, Battery FAE
Sandia National Laboratories	
Sanyo Energy (USA)	Chief Researcher
Sasol North America	
Setaram Inc.	Sales & Marketing Coordinator

Organization	Title
Sharp Labs of America	
Showa Denko America	Sales Assistant Manager
Solvay	Manager
Sony	
Sony Corporation	
Southwest Electronic Energy Group	PRESIDENT
Southwest Electronic Energy Group	Senior Technical Staff
Spectrum Brands - Rayovac	
Spectrum Brands, Inc.	Principal Scientist
Stanford University	Associate Professor
Stanley / Black & Decker	Senior Project Engineer
StrenuMed	President
SumitomoManager	
Swerea IVF	
Targray Technology	Product Manager
Targray Technology	Regional Sales Manager
TDI Power	CTO
TDI Power	VP Engineering
Teradyne Advanced Battery Systems	Marketing
Teradyne	Manager, Business Development
Teradyne	Systems Engineer
Texas Instruments	Sector Manager
The Gillette Company	Group Leader / Staff Scientist
The Technology Partnership Plc	Business Manager
The Toro Company	
Thermal Hazard Technology	Sales Director
Thermal Hazard Technology	Director North American Operations
Thermal Hazard Technology	Founder
Thoratec Mfg.	Engineer
TIAX LLC	Vice President, Technology
Tohoku University	Associate Professor
Toshiba Corp	
Tracer Technologies	
U.S. Army Research Laboratory	Research Chemist
UC Santa Barbara Professor	
Ulbrich, Inc.	
Ultralife Batteries Inc.	Research Manager
Ultralife Batteries, Inc.	Vice President of China Operations
UMICORE CANADA INC.	
Underwriters Laboratory	Senior Research Engineer
University of Alabama	Professor Of Chemical Engineering
University of Hawaii at Manoa	
University of Kiel	Professor
University of Massachusetts	Manager, R2R Lab
University of Massachusetts Boston	Professor

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