Next Generation

Batteries 2012

July 19-20, 2012
Boston, MA USA

Application Driven Development of New Battery Chemistries & System Designs - *Lithium & Beyond*

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July 19-20, 2012
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COMPREHENSIVE DOCUMENTATION AVAILABLE

Nothing can substitute the benefits derived from attending **Next Generation Batteries 2012**. But if your schedule prevents you from attending, this invaluable resource is available to you. Please allow 5-7 days after the conference date for delivery. *Note: Documentation is included with conference fee for registered delegates*

Thursday, July 19, 2012

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

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

9:00 **Blending Advanced Battery Chemistries Targeted at the Automotive Market**

John Warner, PhD, Director, Product Management, Large Format Batteries, Boston-Power, Inc.

Through blending new chemistry combinations with advances in electrolytes in our patented cell design, Boston-Power has developed one of the highest energy density battery solutions available for the EV market today, while continuing to offer industry leading safety, cycle and calendar life. In this presentation, we will demonstrate the advantages of blending commercially available chemistries in a small prismatic cell as the best solution available for automotive electrification.

9:30 **Next Generation High Energy Batteries: Sulfur Cathode vs. Silicon Anode**

Markus Hagen, Fraunhofer ICT, Germany

Lithium-sulfur cells can deliver energy densities 2-4 times as high as state of the art lithium-ion systems. Nevertheless lithium metal anodes cause safety risks. Therefore we propose a lithium-silicon-sulphur cell and would like to present the result of the German joint project "AlkaSuSi" funded by German ministry BMBF.

10:00 **EM1: A 5V Electrolyte Additive Package for Various High Voltage Cathodes**

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

Wildcat has developed a 5 volt electrolyte additive package (EM1) using its high throughput battery development system. EM1 has been shown to be broadly beneficial to a wide range of cathodes, yielding improvements for both for high voltage and high temperature performance. In this talk, I will discuss results from EM1's development effort, including, including a results from CM1, Wildcat's cobalt phosphate cathode with >700 Wh/kg, where we achieved more than 1000 cycles with >80% capacity retention in full cells. We will also include promising cycling results for other high voltage cathode systems including LMNO and Argonne's Li-rich layered oxides when used with optimized versions of Wildcat's new high voltage electrolyte.

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

11:00 **Thin & Flexible Battery: Novel Design and Application**

Hyuk Chang, PhD, Senior Vice President, Director of Energy Lab, Samsung Advanced Institute of Technology (SAIT), Samsung Electronics Co., Korea*

Ever since the intercalation mechanism was adopted in the rechargeable battery technology, Li ion battery has been evolved towards the higher energy and power density for the last two decades. Although the evolution is still going on, those advancements of power source provided functional IT devices of mobility freedom and now this technology is being extended to vehicle application with the development of higher capacity design. Other than these major trends, novel concept of battery could lead another innovation of mobile IT devices if the battery can be form flexible. In this presentation, large capacity, thin and flexible battery of 2.5 Wh capacity in 500 um thick, 500 cm^2 cell area will be presented. This could open new devices such as flexible e-ink display, bendable sensors and even flexible smart IT devices by the revolutionary design of power embedded display. Enabling technologies such as nano sized active materials, gel electrolyte, stretchable electrode and low cost printing process will be discussed along with currently achieved performance data at Samsung. **In collaboration with: Seokkwang Doo and Jae-man Choi*

11:30 **Thin Film & Printed Rechargeable Li Ion Batteries**

Florence Fusalba, PhD, Batteries Program Manager, Laboratory for Innovation in New Energy Technologies and Nanomaterials (LITEN), French Atomic Energy Commission (CEA), France

The lithium-ion battery developed by CEA is conformable or flexible, with a 2D flat geometry design for ease of integration or attachment to curved surfaces. It is manufactured using either coating or printing technologies, which means it can be thinner than 4mm for coating or than 1mm for printing but has an increased surface area than other batteries. It can be produced cheaply, is rechargeable, light, with low environmental impact and can also be laminated. It finds application as power source for energy or power profiles of use in autonomous devices with or without energy harvesting for lighting, wireless sensors or long distance communication in various fields (textile, tags, vehicles, buildings, etc.)

12:00 **How the Coming Shortage in Critical Metals will Impact the Supply Chain for Next Generation Batteries**

Michael Silver, CEO, American Elements

The 17 rare earths, including lanthanum and neodymium, lithium and several other materials critical to the manufacturing of next generation batteries are either in short supply or concentrated in the hands of a single nation. This presents significant global strategic supply chain issues for America and the rest of the industrialized world which must be addressed at many levels including in our approach to environmentalism, academic training, anti-trust laws and strategic foreign policy considerations.

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

2:00 **Rechargeable Metal-Air Battery System**

Harvey Mancey, Executive Vice President, ReVolt Technology LLC

ReVolt Technology is one of world's leading developers of rechargeable Metal-Air battery systems. With offices in Portland, Oregon and Dortmund, Germany ReVolt's rechargeable Metal-Air technology is set to revolutionize energy storage in grid level and electric vehicle applications. In this presentation ReVolt will introduce its new Zinc-Air Flow Battery system and provide an overview of progress on technical achievements as they aim to commercialize systems with energy densities as high as 800Wh/l and 400Wh/kg combined with industry leading safety, low environmental impact and low cost of manufacture.

2:30 **Development of Zinc-Air Batteries**

Michael Oster, CEO, Eos Energy Storage, Inc.

Eos Energy Storage has developed a unique energy storage technology: the first long-life zinc-air electrically rechargeable battery. The Eos Aurora is a proprietary enhanced zinc-air battery that can be used to meet the energy storage needs of utilities, electric vehicles, military, and other industrial and commercial applications. Eos's innovations include electrolyte and additives, materials and treatment, architecture, and other systems. These attributes enable a low cost ($160 per kWh at the start), long cycle life (10,000 cycles or 30-years of active and deep use), safety (nothing in the system is toxic or flammable, and the system is self-healing), energy density (a multiple the density of Li Ion at the system level), and manufacturability.

3:00 **Rechargeable Silver-Zinc Microbatteries**

Troy Renken, Vice President, ZPower LLC

The high energy density of a rechargeable silver-zinc battery makes it an attractive alternative to primary and secondary chemistries in microbattery applications. Rechargeable silver-zinc batteries historically have been packaged in large, vented cases. Advances in materials technology, manufacturing processes and charging methods have allowed this chemistry to be scaled down and operate in sealed, button and coin cells.

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

4:00 **Numerical Coupling and Multi-Scale Modeling for Batteries**

John A. Turner, PhD, Group Leader, Computational Engineering & Energy Sciences, Oak Ridge National Laboratory

We present a simulation framework for rigorous, coupled, multi-scale modeling of battery systems. At the macroscopic, engineering scale we use a single-domain volume-averaged formulation capable of resolving complex geometries along with stable and efficient numerical algorithms. A particle-resolved finite-volume approach is used at the mesoscale level, based on fully-resolved, statistically-rigorous microstructure models informed by experimental data on particle morphology to develop upscaled quantities for the macroscopic simulations. We describe the status of the development effort, advantages and drawbacks of our approach, and provide initial results for both conventional and more exotic battery systems.

4:30 **Operando Studies of Electrode Materials for Li-Ion Batteries**

Lorenzo Stievano, PhD, Professor, Université Montpellier 2 - Sciences et Techniques, France

Conversion materials are a class on novel materials providing specific capacity and energy density higher than classic electrode materials (such as graphite) usually employed in Li-ion batteries. In this presentation, we will underline the importance of the use of operando techniques in the study of electrode materials for Li-ion batteries.

5:00 **Direct Dry Formation of Cathode Electrodes for Lithium-Ion Batteries Using a One-Step Combustion Process**

Justin Roller, Researcher, Center for Clean Energy Engineering, Dept of Chemical Material and Biomolecular Engineering, University of Connecticut*

This presentation will discuss alternate fabrication routes for lithium-ion electrodes using a dry one-step direct deposition technique to engineer both the electrode morphology and cathode particle size. The resultant thin layers, comprising mixed nickel cobalt oxide nanoparticles, are directly deposited onto an aluminum current collector with a flame combustion process. The process removes several manufacturing steps, eliminates the need for binder and calendaring while combining powder production, film formation, and mixing into one step.
**In collaboration with: R.Jain and R.Maric*

5:30 *Open Discussion, End of Day One*

Friday, July 20, 2012

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

9:00 **Nanofiber/Microfiber Lithium Ion Battery Separators for Higher Power and Faster Recharge**

Brian Morin, PhD, President & COO, Dreamweaver International

Current stretched porous film battery separators for lithium ion batteries are thin, strong, and provide a good barrier between electrodes, at the cost of having very high internal resistance and low ionic flow due to low porosity (generally <40%) and high 'dead space' that come from starting with a solid material and trying to impart porosity. This work uses an alternative approach, where linear nanofibers and microfibers are combined in wet laid nonwoven processes to give separators that are strong and thin, but have higher porosity (60-70%) and so have much higher ionic flow. Batteries made with these separators have shown 25% increase in energy density, 300% higher power and 4x the recharge rate of similar batteries made with incumbent film materials. Ionic resistivity is as low as 200 Ohm-cm, compared to 1600 Ohm-cm in stretched film materials. Temperature stability is also improved, from a current stability temperature of about 110 C up to 175 C. The material has been produced in production quantities and is available at up to 10,000,000 m^2/year. Applications include all power source applications that require high energy density, high power, high temperature stability, including cell phones, laptop and tablet computers, power tools, and electric and hybrid vehicles. For example, the increased charging rate could take the distance traveled per hour of charge from 10 miles/hour of charge up to 40 miles/hour of charge, allowing a full recharge of a Chevrolet Volt in approximately one hour.

9:30 **Surface-Mediated Cells (SMCs): Next Generation High-Power and High-Energy Batteries**

Bor Z. Jang, PhD, Co-Founder and CEO, Angstron Materials, Inc.

Scientists at Angstron Materials, Inc./Nanotek Instruments, Inc., have developed a game-changing energy storage device that can deliver both high energy and high power. The new surface-mediated cell (SMC) operates on the exchange of massive lithium ions between surfaces of a nano-structured anode and surfaces of a graphene-based cathode. In both electrodes, graphene surfaces are capable of rapidly and reversibly capturing and storing lithium ions, completely removing the need for lithium ions to undergo intercalation or de-intercalation. The new SMCs are already capable of storing an energy density of 160 Wh/kgcell, which is 30 times higher than that of conventional symmetric supercapacitors. The power density of 93 kW/kgcell is 100 times higher than that (0.5-1.0 kW/kgcell) of conventional lithium-ion batteries and > 10 times higher than that (4-8 kW/kgcell) of supercapacitors, which are noted for their high power densities.

10:00 **Simultaneously Enhancing Ionic Conductivity and Mechanical Properties of Solid Polymer Electrolytes (SPE) Via a Copolymer Multi-Functional Filler**

Weihong (Katie) Zhong, PhD, Professor, School of Mechanical and Materials Engineering, Washington State University

It is a compelling challenge to improve both ionic conductivity and mechanical properties in polymeric electrolytes, and to accomplish it through a simple processing method. Our study reveals that poly(ethylene oxide) -block- polyethylene (PEO-b-PE) possesses a capability for enhancing the multiple performances of poly(ethylene oxide) (PEO)-based polymer electrolyte. The effects of composition and molecular weight of the copolymers on performance of the resulting SPEs were examined.

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

11:00 **Simultaneous Ionic and Electronic Current Measurements of a LiCoO2 Battery Cathode Material**

Keith Jones, Application Scientist, Asylum Research*

Electrochemical strain microscopy (ESM) is an innovative new scanning probe microscopy technique that is capable of probing electrochemical reactivity and ionic flows in solids on the sub-ten-nanometer level. In ESM, a biased SPM tip concentrates an electric field in a nanometer-scale volume of material, inducing interfacial electrochemical processes at the tip-surface junction and diffusive and ionic currents through the solid. These changes cause small strains in the solid on the order of a few picometers. The electromechanical coupling is usually small enough to require the use of the cantilever contact resonance to enhance the signal. We have combined another AFM technique called Dual AC™ Resonance Tracking (DART) and ESM measurements with more conventional electronic current measurements to study the both ionic and electronic current flows in a Li-ion battery cathode material. The capability to probe these electrochemical processes and ionic transport in solids is invaluable for a broad range of applications for energy generation and storage ranging from batteries to fuel cells. ESM has the potential to aid in these advances with two major improvements over conventional technologies: (a) the resolution to probe nanometer-scale volumes and (b) the inherent ability to decouple ionic from electronic currents with imaging capability extended to a broad range of spectroscopy techniques. We'll discuss how this technique works, how it is implemented on Asylum Research Atomic Force Microscopes, and give examples of samples that have been imaged using ESM. **In collaboration with: R.Proksch, Asylum Research; and S.Kalinin, ORNL*

11:30 **Hybrid Electrical Energy Storage Systems**

Naehyuck Chang, PhD, Professor, Embedded Low Power Laboratory, Seoul National University, Korea

Despite active research on the new battery technologies, it is not likely for us to have an ultimate high-efficiency, high-power/energy capacity, low-cost, light-weight, and long-cycle life batteries in the near future. In computer systems, system architects have been faced with the same problems over decades as there is no single type of memory device in the world that simultaneously provides high-speed, low-cost, large-density, low-power, nonvolatile, long-endurance, and so forth. Computer systems thus use memory hierarchy such that L1 cache, L2 cache, L3 cache, main memory, storage, etc., to exploit the advantages and to hide shortcomings of each memory device. The proposed hybrid electrical energy storage system idea is analogous to the computer memory hierarchy. We use two or more heterogeneous electrical energy storage elements (various types of batteries and supercapacitors), thereby realizing higher cycle efficiency and longer battery life. This talk introduces the architecture and management of the hybrid electrical energy storage system.

12:00 **Exploit New Pseudocapacitive Metal Oxide Materials for Supercapacitor Applications**

Dongfang Yang, PhD, Senior Research Officer, Industrial Materials Institute, National Research Council of Canada

Pseudocapacitance resulting from either rapid adsorption/desorption superficial reaction or multi-electron-transfer faradic reactions with fast charge/discharge properties are typically 10 times greater than electric double-layer capacitance. RuO_2 can deliver a high capacity up to 700 F/g and show excellent cyclic durability. However, RuO_2-based supercapacitors are too expensive for commercial applications. Many transition metal oxides, such as MnO_2, NiO, Co_3O_4, show excellent pseudocapacitive behaviours and are very promising candidates for electrode materials in supercapacitors. However, the relatively low specific capacitance and low electrical conductivity of these transition metal oxides needs to be improved. Elemental doping of pseudo-capacitive transition metal oxides to form binary or ternary mixed oxides is proved to be very effective way to increase their specific capacitance, electrical conductivity and cycle durability. This talk will present a few examples on developing doped metal oxides such as Co-doped

Mn_2O_3, V-doped doped MnO2 and Co or V-doped amorphous MnO_x prepared by thin film physical vapour deposition (PVD) processes such as pulsed laser deposition (PLD). Thin films of those pseudocapacitive metal oxides were characterized by XRD, FE-SEM/EDX for phase identification and micro-structural evaluation. A comparison of pseudo-capacitance of various doped and un-doped metal oxides was given. This work demonstrated that PVD processes such as PLD is a very promising technique for supercapacitor material research due to its excellent flexibility and capability of controlling microstructures, composition and phases of various materials.

12:30 *Lunch on Your Own*

2:00 **Reducing Sugar-Air Batteries**

Bor Yann Liaw, PhD, Hawaii Natural Energy Institute, University of Hawaii at Manoa

Using reducing sugars as the source of chemical energy and harnessing power via partial oxidation of sugar in an electrochemical device, we showed that significant level of power could be generated at ambient temperature and pressure in a quiescent mode of operation. We will discuss the fundamental process involved and the potential of this battery chemistry for future mobile or stationary applications.

2:30 **Soy Protein-Based Ultra Elastic Polymeric Electrolyte**

Weihong (Katie) Zhong, PhD, Professor, School of Mechanical and Materials Engineering, Washington State University

Ultra elastic and superior ionic conductive solid polymer electrolytes (SPEs) are prerequisite for the development of foldable/flexible devices of next-generation electronics and high power density applications. Developing such high performance SPEs using a bio-material and an environmentally benign approach is more challenging. We developed rubber-like, soy protein-based SPE by controlling the denatured structure of soy protein isolate (SPI). The SPE possesses a fully amorphous uniform structure.

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

3:30 **Methods for Good Material Selection and Battery Lifetime Improvement**

Sanjay Patel, PhD, Director of Analytical Services, Evans Analytical Group

The battery industry has made significant advances in recent years to improve the performance and lifetime of today's batteries. In this talk, we will discuss analytical methods that allow good material selection during battery manufacturing. One important consideration is controlling the composition and impurity level from one material supplier to another or even from batch to batch from the same supplier. Battery lifetime degradation is known to be caused by the continuous growth of an SEI film on the surface of electrode particles. Characterizing this layer allows a better understanding of electrochemical processes and results in improved battery design. We will discuss the technical challenges associated with analyzing this critical film.

4:00 **Intercalation Physics of Molybdenum Disulphide and Rational Designs**

Jun Li, PhD, Ningbo Institute of Material Technology and Engineering, Chinese Academy of Sciences, PR China

This talk presents in microscopic detail the nature of intercalation physics in a prototype material (molybdenum disulphide, which is attracting increasing interests for applications recently). Accurate first-principles calculations are used to explain experimental results. Details of how electronic structures drive lithium ion intercalation are explained. We show the cycling reversibility of Li ion intercalation is crucially governed by a principle of maximum hardness, and suggest possible ways to improve it.

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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Boston, MA USA

Conference Registration

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Discount Accommodations and Travel: A block of rooms has been allocated at a special reduced rate. Please make your reservations by June 17, 2012. When making reservations, please refer to the The Knowledge Foundation. Contact The Knowledge Foundation if you require assistance.

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