



18<sup>th</sup> Annual

# advanced automotive battery conference

June 4-7, 2018 • Hotel Del Coronado, San Diego, CA

## Final Agenda

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# CONFERENCE AT-A-GLANCE

**June 4**  
Partnering Summit  
& Tutorials

**June 4-5**  
R&D Symposia

**June 6-7**  
Application Conferences



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## PLENARY SESSION Wednesday, June 6

### MARKET EXPANSION OF xEVs AND THEIR BATTERIES



#### 9:05 Low-Carbon Vehicles: Technology, Incentives, Regulations, and Customer Interest

*Dan Sperling, PhD, Distinguished Blue Planet Prize Professor of Engineering and Environmental Science and Policy, ITS Davis*

What is the role of policy and consumer preferences in the transition to electrified vehicles? In this talk, both light and heavy duty vehicles will be addressed, including buses—with a focus on California and the US, but also with reference to Europe and China. I will address the historic and future role of vehicle performance standards, ZEV mandates, and vehicle purchase incentives (cars, trucks, and buses), and provide some insights and evidence about consumer and vehicle supplier responses to these policies and incentives.



#### 11:00 xEV-Architecture Directions in the Major World Markets

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

This presentation will assess the expansion of the xEV market. It will show that while xEV market expansion is now unstoppable, the pace of growth for each of the of xEV architectures is tied to i) regional-government regulations, ii) battery and vehicle technology and cost development, and iii) consumer eagerness. Predicting the growth of both the xEV market and the batteries that will power the vehicles is thus tied to anticipating development in the above three areas. We will attempt to provide some likely scenarios and estimate the resulting battery and xEV markets.



#### 9:25 xEV Implementation – What's Working and What's Not?

*Ted Miller, Senior Manager, Energy Storage Strategy and Research, Ford Motor Company*

Vehicle electrification is now occurring apace due to a variety of factors, including regulatory pressure, environmental concerns, and customer preference. There are key economic and technical enablers in play that are helping to usher xEV implementation. However, barriers to universal adoption remain. This presentation will consider what's working (enablers), such as increasing fuel cost and air quality concerns, as well as technical successes, including lower battery cost, increased energy density, and fast charging. Among the barriers, or what's not working, considered are vehicle package compromise, low temperature operating penalty, materials cost, etc.



#### 11:30 Key Issues in Promotion of Chinese plug-in Vehicles and the Differences between Chinese NEVs and those in the Rest of the World

*Mark Lu, PhD, Certified Senior Industrial Analyst, Industrial Economics & Knowledge Center (IEK), Industrial Technology Research Institute (ITRI)*

In the past 5 years, the Chinese xEV market has become the biggest plug-in vehicle market in the world. Compared to the US, the promotion of Chinese New Energy Vehicles (NEVs) covers a number of key issues like policies, subsidies and regional promotions. Therefore, this presentation will highlight the differences between Chinese NEVs and the rest of the world's. In addition, technical & industrial battery requests and the material supply-and-demand relationship will also be covered.



#### 9:45 Toyota's Views on Electrification of Major World Vehicle Markets

*Michael Lord, Executive Engineer, Toyota Motor Engineering & Manufacturing, NA*

In the race towards electrified transportation, multiple regional and national policies are pushing and pulling OEM product strategies, often in different directions. Every OEM is looking to align electrified product strategy not just with these policies but also market conditions. This presentation will review Toyota's view on this topic and will touch upon worldwide sales trends, our expectations of market pull for different xEV technologies, and what the future might have in store.



#### 12:00 pm Latest Analysis of xEV and LIB Battery Technology and Market Trends

*Takeshi Miyamoto, Senior Vice President, B3 Corporation*

BEV/PHEV markets are continuing significant growth in these years with the future tighter environmental regulations as a background. B3 will present results for the latest status of the xEV market, examine the latest status of the LIB suppliers, and describe noteworthy moves including technology trends in this industry.



### MONDAY, JUNE 4

7:00 am Summit Registration & Morning Coffee

#### OVERVIEW OF THE EARLY STAGE INVESTMENT LANDSCAPE

8:15 Organizer's Opening Remarks

*Shannon Given, Editor, Cambridge EnerTech*

8:20 Navigating the Landscape of Structuring Partnership Agreements for Early Stage Companies

*David Jacoby, President, Boston Strategies International*

Early stage investments in EV require partnerships, but they also require the development of strategic customer relationships and intellectual property. How can you be proactive and early to the market while avoiding the erosion of strategic customer relationships and intellectual property to partners who you may not be married to for the long term? Hear examples of agreement structures and relationships that balance risk and reward for early-stage partnerships.

9:05 STRATEGIC INVESTING PANEL  
DISCUSSION: Partnering & Investing on the Convergence of Mobility, Artificial Intelligence, Energy Storage & Renewable Energies

*Moderator: Dirk Michels, Partner, Energy and Project Finance Group, Ballard Spahr LLP*

*Saman Farid, Managing Partner, Comet Labs*

*Joshua Posamentier, Co-Founder and Managing Partner, Congruent Ventures*

*Hara Wang, Associate, Braemar Energy Ventures*  
*Cassie Bowe, Associate Vice President, Energy Impact Partners*

By 2030, it is predicted that 95 percent of US passenger miles will be served by on-demand autonomous EVs owned by fleets in a business model dubbed "transport-as-a-service" (TaaS), whose market size is expected to exceed \$120 billion by 2025. Discover what VCs look for in funding companies and new business strategies in a TaaS based economy and how to ready your company to participate in the upcoming mobility disruption.

10:00 Networking Coffee Break & 1-1 Partnering Meetings

#### INNOVATION SHOWCASE FOR AUTONOMOUS VEHICLES

11:00 Economical, Scalable, and Precise Autonomous Vehicle Localization and Navigation with 'Fingerprint' Technology

*Paul Drysch, Vice President, Sales and Business Development, Civil Maps*

Civil Maps provides vehicular cognition for self-driving cars, emulating the mental routines of human cognition used in the tasks of driving and navigation. Fingerprint Base Map (FBM) serves as a component in Civil Maps' cognition offering, enabling autonomous vehicles to understand where they are in the world and what is around them. Unlike solutions that are dependent on processing hardware and third-party data centers, FBM is utilized entirely on-the-edge, in-vehicle.

11:15 Wireless Charging: Integrating Electric Vehicle Autonomy, Renewables, and Battery Storage

*Jeremy McCool, CEO, HEVO, Inc.*

HEVO represents how to achieve electric vehicles adoption, and accelerate renewable development and energy storage implementation. As autonomy becomes more prevalent in disrupting the transportation industry, and electric vehicles become the common platform, it is required that ubiquitous universal charging be made available, and seamlessly connected to renewables and battery storage. Only through the integration of this ecosystem will the full potential of all technologies and industries be fully realized.

11:30 Connected Car Keeps Drivers Safe

*Ezana Tesfu, Director, Operations, CarVi*

CarVi device prevents drivers from a dangerous situation by giving them real-time alert and feedback on their driving behavior. A connected car is improving and reducing auto accidents on the road and expediting the claim on insurances.

11:45 STRATEGIC INVESTING PANEL  
DISCUSSION: Investing in the Potential of Global Automotive Innovation

*Moderator: Ken-Icho Hino, Director, Custom Research, Cleantech Group*

*Panelists: Quin Garcia, Managing Director, Autotech Ventures*

*Kevin Deneen, Senior Associate, Aster Capital*  
*Andrew Byrnes, Investor, Comet Labs*

The transportation sector is undergoing several epochal changes simultaneously: autonomous driving, electric vehicles, and connected cars. Each will significantly impact the auto sector. This panel gives a glimpse of the future opportunities globally, the innovation centers across the globe, and how VCs harness the investment potential in these different areas.

12:40 pm Lunch & 1-1 Partnering Meetings

#### INNOVATION SHOWCASE FOR AUTOMOTIVE COMMERCIALIZATION

2:00 Chairperson's Remarks

2:05 Solid-State Batteries for an EV-Driven Future

*Erik Terjesen, Senior Director, Licensing and Strategy, Ionic Materials*

One of the largest barriers holding back electric vehicles from widespread adoption is range anxiety. To enable a green future that's powered by affordable, long-range EVs, car manufacturers are cranking up R&D efforts around solid-state battery solutions. In this session, attendees will learn about the different advantages of solid-state systems and, specifically, how they will increase EV range by allowing for previously inaccessible, higher energy density, battery chemistries.

2:20 Technology to Prevent Drunk Driving

*Catherine Carroll, COO, Sober Steering*

Sober Steering developed a touch based alcohol interlock to prevent drunk driving. Upon ignition, drivers place a hand on our biosensor in the wheel, which detects alcohol by touch. If alcohol detected exceeds a pre-set limit, the vehicle is immobilized.

Sober Steering completed a prototype wearable alcohol sensor that detects alcohol in real-time. The biosensor technology is small, rugged, inexpensive and specifically designed for industrial and automotive use.

2:35 How Do We Power Millions of EVs?

*Jason Appelbaum, CEO, EverCharge*

With many new electric vehicles slated for 2020 and beyond, cities, consumers, and OEMs must consider how they plan to power these vehicles. Investing in a massive infrastructure overhaul will be time consuming and expensive. However, by leveraging smarter dynamic charging technology, we can power more vehicles by simply using power more efficiently.

2:50 STRATEGIC INVESTING PANEL  
DISCUSSION: Alternative Investing Structure

*Moderator: Richard Baxter, President, Mustang Prairie Energy*

*Panelists: Conrad Burke, Vice President of New Ventures, Intellectual Venture*

*Paul Ho, Managing Director, AIM*

*Robert Rango, President & CEO, Enevale*

*Lauren Burrows, Principal, WindSail Capital Group*

Investment is surging into all facets of the EV supply chain as the opportunity to gain a piece of the evolving new vehicle market emerges. This panel will evaluate the opportunities of alternative investment structures that allow institutional and strategic investments to marry innovative technologies and business models with investment firms with deep pockets, access to customers and partners, and the understanding on how to navigate small companies on high growth trajectories.

3:50 Networking Refreshment Break & 1-1 Partnering Meetings

#### INNOVATION SHOWCASE FOR AUTOMOTIVE BATTERY COMMERCIALIZATION

4:50 Commercialization of a New Class of Additives to Improve Li-Ion Abuse Tolerance

*Steven Weiss, PhD, President, Xiletric, Inc.*

Xiletric has developed a new approach for managing electrolyte degradation. The technology helps with high voltage, high temperature, and fast charge. More generally, the technology improves the abuse tolerance of Li-ion batteries. We have shown a greater than 2.5x lifetime increase for a variety of electrolyte and cathode formulations.

5:05 Liquefied Gas Electrolytes for Lithium Batteries

*Jungwoo Lee, CEO, South 8 Technologies, Inc.*

A novel class of electrolytes using liquefied gasses for lithium batteries has demonstrated compatibility with lithium metal and high voltage cathodes, excellent performance from ambient to -60°C, and improved safety through the mitigation of thermal runaway. The improved energy density from the use of lithium metal with high efficiency and NMC cathodes with stable performance will push this technology beyond the 400 Wh/kg threshold while maintaining excellent cycle life.

5:20 Close of Summit



## 8:00 - 10:00 AM

### **TUT1: The Rechargeable Battery Market: Value Chain and Main Trends 2017 - 2027**

*Instructor: Christophe Pillot, PhD, Battery Survey Manager, Avicenne Energy, France*

This tutorial will present the 10-year automotive market forecasts from Avicenne and other analysts (microHybrid|P-HEV|EV). Other coverage will include car makers' strategies, advanced energy storage (Advanced lead acid|Supercap|NiMH|LIB). Additionally, LIB design for P-HEV & EV markets (Cylindrical, prismatic, pouch|Wounded, stacked, Z fold cells) and LIB cell, module & pack cost structure 2017-2027 will be discussed.

### **TUT2: Recent Advances in Solid State Electrolytes for Energy Storage**

*Instructor: Steve Visco, PhD, CEO & CTO, PolyPlus Battery Co.*

Dangerous liquid electrolytes are employed over solid electrolytes due to their high conductivities and excellent interfacial behavior. However, current research is narrowing the gap between liquid and solid electrolytes. This tutorial will provide a review of advances in solid electrolyte, from material synthesis, to interfacial stability, to practical device applications.

### **TUT3: Improving the Energy Density of Batteries with Silicon-Based Anodes**

*Instructor: Dee Strand, PhD, CSO, Wildcat Discovery Technologies*

This tutorial gives an overview on the benefits and challenges of using silicon-based anodes to improve the energy density of lithium-ion batteries. Topics will include 1) the key challenges in use of silicon-based anodes as well as progress

in implementation of silicon and what can we expect in the future, and 2) the latest improvements in other battery components required to maximize the benefit of silicon-based anodes.

## 10:30 AM - 12:30 PM

### **TUT4: Innovations in Packaging and New Regulatory Requirements for Transportation of Batteries**

*Instructor: Bob Richard, President, Hazmat Safety Consulting LLC*

This tutorial will cover new packaging and fire suppression innovations and products and also provide an update on planned regulatory changes that will impact any company that ships lithium batteries. This will include the SAE G27 Lithium Battery Packaging Standard for air shipments and the UN Transport of Dangerous Goods Sub-Committee initiative to develop a hazard based classification system for lithium batteries based in their inherent risks. These looming regulatory changes will impact the entire lithium battery industry.

### **TUT5: Materials for Next Generation Batteries**

*Instructor: George Crabtree, PhD, Director, Joint Center for Energy Storage Research (JCESR), Argonne National Laboratory & Distinguished Professor of Physics, Electrical and Mechanical Engineering, University of Illinois, Chicago*

This tutorial will cover the materials and performance challenges for next generation batteries for electric vehicles and the electricity grid. The needs and use cases for storage in these two applications will be analyzed, and the

possibilities of advanced lithium-ion, lithium-sulfur and multivalent batteries for vehicles will be presented. Lithium and magnesium anodes, wide electrochemical window electrolytes, and high voltage cathodes will receive special attention. New discovery approaches based on materials simulation and statistical learning will be discussed.

### **TUT6: The Global Electrolyte Market: Competitive Landscape and Market Opportunities**

*Instructor: Sam Jaffe, Managing Director, Cairn Energy Research Advisors*

This tutorial will provide an overview of the electrolyte market, including the competitive landscape, pricing history and market forecast and prospects. The tutorial will then dive into each of the three components of electrolyte: fluorinated lithium salt, solvents and additives. Each electrolyte component will be explored, including an examination of incumbent materials as well as potentially disruptive new entrants, as well as the competitive landscape and pricing regimes. Finally, the tutorial will review next generation materials such as ionic liquids, salt-intensive formulations and others.



# TRAINING SEMINARS

June 6-7, 2018 | Hotel Del Coronado | San Diego, CA

## WEDNESDAY, JUNE 6, 2018 | 9:00 AM – 5:00 PM

### **TS 1: Lithium-Ion Battery Cell and Pack Technology**

*Instructors:*

*Bob Spotnitz, President, Battery Design LLC*

*Kevin Konecky, Battery Systems Consultant, Total Battery Consulting, Inc.*

The first part of this seminar will provide of an overview of lithium-ion cell technology and an in-depth discussion of the principles guiding the design of both high-energy and high-power lithium-ion cells. The second part will present the overall design of battery systems, the product development process, cost, and system validation.

Topics will include:

- Overview of Li-ion cell technology and discussion of the principles guiding the designs of both high-energy and high-power cells and their manufacturing technology
- Porous electrode theory
- Impact of potential improvements in materials and processes
- Introduction to battery systems
- System specification development
- System design: cell and module design, and mechanical, thermal, and battery management (hardware and software)
- Product development process overview w/ key milestones and cost considerations

## THURSDAY, JUNE 7, 2018 | 9:00 AM – 5:00 PM

### **TS2: Battery Safety & Abuse Tolerance Validation**

*Instructor: Shmuel De-Leon, CEO, Shmuel De-Leon Energy, Ltd.*

Batteries have become daily use components for many applications. New growing segments like EV and grid storage batteries extend the traditional ordinary battery applications. In the race for energy density, we should not forget the safety (e.g., the Samsung Galaxy Note 7 battery safety case). Unfortunately, we face daily safety events with injuries and severe damage. This training program focuses on portable, stationary and automotive battery safety along the battery cycle life (acceptance, testing, assembly, use, transportation and disposal). The training incorporates Shmuel De-Leon's and other experiences on battery safety representing over 26 years of work in the field. The motivation behind the training is to provide attendees with the knowledge needed to safely handle the batteries in their organization and to support reduction in safety events.

Topics will include:

- Primary Cells and Batteries
- Battery Essentials
- Rechargeable Cells & Batteries
- Battery Safety Hazards
- Battery Safety Guidelines
- Battery Safety Equipment
- Battery Safety Design
- Battery Disposal
- Battery Transportation
- Battery Safety Standards & Testing
- EV Battery Safety





# BATTERY CHEMISTRIES FOR AUTOMOTIVE APPLICATIONS

## Recent Advancements in Battery Chemistries

June 4-5, 2018 | Hotel Del Coronado | San Diego, CA

MONDAY, JUNE 4

12:30 pm Symposia Registration

### ADVANCEMENTS IN LITHIUM-ION BATTERIES

#### 1:30 Chairperson's Opening Remarks

*Martin Winter, PhD, Chair, Applied Material Science for Energy Conversion and Storage, MEET Battery, Research Center, Institute of Physical Chemistry, University of Muenster*

#### 1:35 Present Status and Future Requirements for Energy Storage for Vehicle Applications

*Venkat Srinivasan, PhD, Director, Center for Collaborative Energy Storage Science, Argonne National Laboratory*

This talk will summarize the state-of-the-art of battery technology when compared to the needs for vehicle applications. Using techno-economic modeling efforts at ANL, we will summarize the prospects of Li-ion, Li-metal (including Li-air and Li-S), and Mg-ion based systems compared to the requirements. We will also summarize the key targets for materials for these future chemistries, derived from continuum models, with an eye on requirements for enabling Li metal.

#### 1:55 Improving Li-Ion Energy and Cycle Life at the Negative Electrode

*Mark Obrovac, PhD, Professor, Chemistry and Physics, Dalhousie University*

There are a number of opportunities to increase cell energy and cell cycle life by improvements at the negative electrode. Using simple materials and methods, Si alloys can be obtained having greatly improved handling properties and cycling performance. It will also be shown that improvements to cell cycle life can be made from considering inactive cell components interactions with electrolytes and additives.

#### 2:15 Exploring Safety and Performance Concerns Associated with Si-containing Lithium-ion Cells

*Daniel Abraham, Ph.D., Materials Scientist, CSE, Argonne National Laboratory*

The excessive volume changes and continual SEI growth during electrochemical cycling have limited the use of silicon-based anodes in lithium-ion cells. In this presentation we will discuss the performance of cells, in which Si-Gr electrodes are paired with layered transition metal oxides, during calendar and cycle life aging. We will also highlight the gassing (hydrogen generation) associated with the processing of Si-based electrodes from aqueous slurries, and present approaches for its mitigation.

#### 2:35 Silicon-Dominant Anodes in Electromobility Chemistries for Extreme Fast Charge Capable Batteries

*Benjamin Park, Ph.D., Founder and CTO, Enevate Corporation*

Enevate's silicon-dominant anode (>70% silicon) and Li-ion cell technology utilizes a self-standing film without typical battery binder materials. Batteries using Enevate's anode offer extreme fast charge with high energy density, wide temperature operation, and safety. Data will be shown along with analysis of other potential technology benefits for EV applications.

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#### 2:55 Refreshment Break

#### 3:15 Development of Advanced Materials for xEV Cells

*Chengdu Liang, PhD, Dean, Research Institute, CATL*

With the growing of xEV market, the demand for high energy battery chemistry with reliable electrochemical properties becomes the major topic of battery research. In this presentation, we will share the latest development of cathode, anode, and electrolyte from the viewpoint of xEV applications. The topic will focus on high nickel cathode and silicon anode materials.

#### 3:35 High Capacity Cathodes Invoking Oxygen Redox

*Peter Bruce, PhD, Faraday Challenge Institute*

The search for Li-ion battery cathodes that exceed the limits of Ni rich NCM presents a significant challenge. One possible route is to store charge on the oxygen as well as the transition metal of lithium transition metal oxide cathodes. To harness the opportunities such material offer, it is necessary to understand the nature of O-redox processes and the factors that control them. O-redox in 3d transition metal oxides will be discussed, leading to a new high capacity manganese based cathode that utilizes the full capacity of the Mn as well as charge storage on oxygen.

#### 3:55 Challenges and Opportunities for Implementing High-Nickel Cathode Materials in High-Performance Li-ion Cells

*Suresh Sriramulu, PhD, CTO, CAMX Power*

High-nickel cathode materials are increasingly being considered in Li-ion cells for automotive batteries. This presentation will review the challenges of implementing high-nickel cathode materials, especially in laminate pouch cells. We will discuss how lithium impurities (LiOH and Li<sub>2</sub>CO<sub>3</sub>), in conjunction with surface chemistry of high-nickel cathode materials, promote electrode slurry gelling and gas generation in the cell during elevated temperature storage and cycling. We will show why techniques typically used for measuring such impurities in low-nickel cathode materials are not suitable for high-nickel cathode materials and disclose methods for accurately characterizing such impurities.

#### 4:15 Improvements to Disordered Rock-Salt Li-Excess Cathode Materials

*Dee Strand, PhD, CSO, Chemistry, Wildcat Discovery Technologies*

Cathode materials with higher energy density than layered oxide materials are required for future demands of vehicle electrification. Disordered rock-salt Li-excess structures, such as Li<sub>3</sub>NbO<sub>4</sub>, have been demonstrated to achieve capacities of greater than 300 mAh/g reversible capacities at elevated temperatures. The high capacity is believed to be due to reversible redox chemistry of the oxide anions. This new class of high energy cathode materials provides an opportunity for a step change increase in cell level energy density. However, improvements are still required in material conductivity and stability. In this presentation, we demonstrate material improvements which enable high specific capacity at room temperature and extended cycle life.

#### 4:35 Q&A

#### 5:00 Close of Day

TUESDAY, JUNE 5

8:30 am Morning Coffee

### BEYOND AND ASIDE LITHIUM-ION BATTERIES

#### 9:00 Chairperson's Remarks

*Dee Strand, PhD, CSO, Chemistry, Wildcat Discovery Technologies*

#### 9:05 Non-carbonate Electrolytes for High Voltage/High Ni Chemistries

*Kang Xu, PhD, Senior Research Chemist & Project Lead, US Army Research Lab*

Dialkyl carbonate ester have been used as main electrolyte solvent since the dawn of Li-ion batteries and remains dominant in today's LIB market. However, such solvents are intrinsically unstable with the next generation cathode materials of either high voltage (>4.5 V) or high Ni content. In this work we attempted to replace resolve these problems with a new class of non-flammable non-carbonate solvents that don't generate gas at high V.

#### 9:25 The Battery500 Project - Assessing Critical Pathways to Next Generation High Energy Safe Lithium Batteries

*Shirley Meng, PhD, Professor, Director, NanoEngineering & Energy Center,*

**University of San Diego**

Battery500's aggressive goal is to develop next generation batteries that have almost double the specific energy found in the batteries that power today's electric cars. The consortium team hopes to reach the goal by focusing on lithium-metal batteries, which use lithium instead of graphite for the battery's negative electrode. A key focus of the consortium is to ensure the technological solutions it develops meet the needs of automotive and battery manufacturers. I will showcase a few significant innovations that can be potentially implemented by industry throughout the project.

**9:45 Surface and Interfacial Challenges and Opportunities in Rechargeable Lithium Batteries**

*Xingcheng Xiao, PhD, Staff Researcher, Global R&D Center, General Motors Company*

**10:05 Grand Opening Coffee Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)****11:00 Solvay's Recent Developments on Electrolyte Ingredients for High Voltage Li-Ion Batteries**

*Dominick Cangiano, MBA, PhD, Technical Business Development Manager, SOLVAY*

A leading target of the Li-Ion battery industry is to achieve high energy density at affordable cost without compromising on safety. Solvay has increased its efforts to propose innovative electrolyte ingredients to battery makers, enabling high voltage solutions. New results with fluorinated additives and Energain® on silicon graphite/lithium anodes will be presented.

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**11:20 Solid-State Lithium-Metal/Glass-Electrolyte Structures for Next Generation Batteries**

*Steve Visco, PhD, CEO & CTO, PolyPlus Battery Co.*

Li-ion technology has profoundly changed the battery landscape since its commercial introduction in 1991. However, it is now a mature technology, and incremental improvements to the energy density of Li-ion batteries are becoming increasingly difficult to achieve. The replacement of the carbon anode by lithium metal would allow for a substantial increase in energy density, but this is hardly a trivial task. In this presentation, we describe the use of glass protected Li-metal electrodes to eliminate the formation and propagation of Li dendrites, leading to high cycle life and high energy density batteries.

**11:40 Unlimit Energy**

*Qichao Hu, PhD, Founder & CEO, SolidEnergy Systems Corp.*

SolidEnergy has introduced transformational energy storage solutions through its light semi-solid lithium metal batteries. The breakthrough technology incorporates a high concentration solvent-in-salt electrolyte capable of operating at room temperature as well as a protected lithium metal anode that is many times smaller and lighter than a graphite or silicon composite anode. Through these two innovative material platforms, SolidEnergy offers twice the energy density at an incredibly reduced weight when compared to conventional lithium-ion technology.

**12:00 pm Cathode Design Considerations for Bulk Solid-State Batteries**

*Josh Buettner-Garrett, PhD, CTO, Solid Power Inc*

Solid-state batteries are now emerging as the greatest threat to conventional Li-ion batteries. Most R&D activity to this point has focused on topics such as

electrolyte conductivity and enablement of Li metal anodes, but solid-state composite cathodes that provide high energy density and long cycle life are also critical. This talk will cover the material, layer design, and processing requirements for a high-performance cathode as well as provide a status update for Solid Power's solid-state cells.

**12:20 Q&A****12:40 Networking Lunch****1:35 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)****2:35 Chairperson's Remarks**

*Andreas Hintennach, PhD, Professor, Research HV Battery Systems, Daimler AG*

**2:40 Post and Beyond Lithium-Ion Materials and Cells for Electrochemical Energy Storage**

*Andreas Hintennach, PhD, Professor, Research HV Battery Systems, Daimler AG*

Novel and sustainable electroactive materials can help to decrease the ecological impact of novel battery concepts in the near future. While on the one hand high energy density is required, the aspects of safety, lifetime get more important and often mean a challenge. All these requirements are met by very different approaches with different characteristics: all solid-state cells, high-energy materials, lithium-sulfur and even different systems e. g. Na- or Mg-Ion.

**3:00 Beyond Lithium, Novel Lithium Sulfur System and Lithium Superoxide**

*Khalil Amine, PhD, Manager, Advanced Battery Technology, Argonne National Laboratory*

In this talk, we will report on a novel Sulfur doped Selenium system coupled with a novel electrolyte that overcomes both the conductivity issue of sulfur and the shuttle effect caused by polysulfide ions. We will also disclose a new close system based on stabilizing crystalline Lithium superoxide that offers a real opportunity of achieving at least 500wh/kg.

**3:20 Conversion-Type Active Materials & Processes for Safer, Higher Energy Density Batteries**

*Gleb Yushin, PhD, Professor, School of Materials Science and Engineering, Georgia Institute of Technology*

Energy density and cost of Li-ion batteries (LIBs) based on conventional intercalation compounds are closely approaching their limits. The reliance of conventional cathodes on the use of toxic metals additionally endangers health and safety of miners in developing countries. Conversion-type active materials offer an opportunity to double energy stored in LIBs, reduce their cost by the same factor, and improve cell safety. These materials may be produced from safer, cheaper and globally available resources and contribute to accelerated adoption of electric transportation.

**3:40 Q&A****4:00 Networking Reception in the Exhibit Hall with Poster Viewing****5:00 Close of Symposium**

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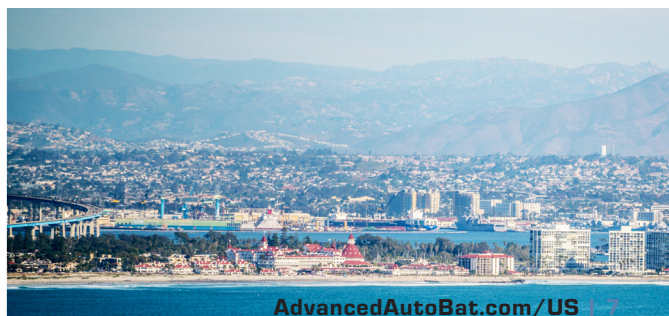
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**Discounted Cut-off Date Extended to:**

May 8, 2018





# BATTERY ENGINEERING FOR AUTOMOTIVE APPLICATIONS

## Building Better Batteries

June 4-5, 2018 | Hotel Del Coronado | San Diego, CA

### MONDAY, JUNE 4

#### 12:30 pm Symposia Registration

### SAFETY

#### 1:30 Chairperson's Opening Remarks

*Brian Barnett, PhD, Vice President, CAMX Power*

#### 1:35 Multiscale Battery Diagnostics for Improved Safety and Performance

*Mohan Karulkar, PhD, Principal Staff Member, Power Sources R&D, Sandia National Laboratories*

Sandia National Laboratories has implemented diagnostics across multiple time and resolution scales to identify safe and effective battery operating conditions. Methods like high precision cycling, advanced EIS, and differential coulometry will be linked to more traditional current/voltage/temperature measurements to assess applications like fast charge, cell abuse, and second use. The impact of charge rate, SOC window, and cell capacity on safety and performance will be discussed.

#### 1:55 Abuse Testing to Understand High Energy Battery Failure

*Joshua Lamb, PhD, Senior Member of the Technical Staff, Advanced Power Sources R&D, Sandia National Laboratories*

The increasing energy and power demands from various applications drive the need for higher energy density batteries, which typically means an increased reliance on lithium-ion batteries. Because of this, complex and high energy density systems composed of lithium-ion cells are becoming more prevalent. This talk shows how Sandia National Laboratories uses abusive battery testing to better understand the potential risks surrounding high energy batteries.

#### 2:15 A New Method for Safety Test of Internal Short Circuit

*Yuya Ishihara, PhD, Assistant Manager, Battery Evaluation & Analysis, Toyota Motor Corporation*

We propose a new method for safety testing of internal short circuit. It is a simple test for lithium-ion cells, using a metal nail.

#### 2:35 Short Detection Technology for Battery Safety

*Brian Barnett, PhD, Vice President, CAMX Power*

Recent events have heightened awareness that internal short circuits are a major cause of Li-ion battery safety events. We have developed multiple, distinct, non-invasive and chemistry-agnostic technologies for sensitive early detection of internal shorts in Li-ion batteries before the shorts pose a thermal runaway threat. We are implementing short detection for several applications and will describe examples of its use and benefits.

#### 2:55 Refreshment Break

#### 3:15 Determining Electrode Tortuosity and Rate Limitations from Experiments and Modeling

*Kandler Smith, PhD, Senior Engineer, Energy Storage, National Renewable Energy Laboratory*

This talk will cover our estimation of graphite and NMC electrode tortuosity – a major factor inhibiting fast charge, for example – from several different methods: (1) direct measurement using symmetric cells, (2) electrochemical testing and fitting via macro-homogeneous models, and (3) predictive modeling via simulation at the 3D electrode microstructure level.

#### 3:35 Advanced Battery Diagnosis and Prognosis Approaches for EV Transportation Applications

*Boryann Liaw, PhD, Department Manager, Energy Storage and Advanced Vehicles, Clean Energy & Transportation Division, Idaho National Laboratory*  
It is inevitable that battery performance, durability, reliability and safety

issues thus continue to escalate as great concerns among end-users, system integrators and battery manufacturers, and regulators. To successfully implement such practices needs an advanced battery diagnosis and prognosis approach. This presentation is intended to discuss this aspect and to explain what it would take to establish such diagnostic and prognostic capabilities currently undertaken at Idaho National Lab.

#### 3:55 Battery Abuse Response: Alternative Characterization Methods and Considerations for Automotive Applications

*Matt Denlinger, Battery Research Engineer, Ford Motor Company*

As lithium-ion battery adoption in the automotive market continues to increase, understanding and characterizing the energetic response of batteries in abusive conditions remains an important consideration. This is especially true as both cell and pack energy density continue to increase. This presentation will review recent methods developed to characterize battery abuse response, and provide context for these reactions with specific considerations for automotive applications.

#### 4:15 Efficient Simulation and Abuse Modeling of Mechanical-Electrochemical-Thermal Phenomena in Lithium-Ion Batteries

*Ahmad A. Pesaran, PhD, Manager, Energy Storage Group, Transportation and Hydrogen System Center, National Renewable Energy Laboratory (NREL)*

#### 4:35 Q&A

#### 5:00 Close of Day

### TUESDAY, JUNE 5

#### 8:30 am Morning Coffee

### PACK ENGINEERING

#### 9:00 Chairperson's Remarks

*Ahmad A. Pesaran, PhD, Manager, Energy Storage Group, Transportation and Hydrogen System Center, National Renewable Energy Laboratory (NREL)*

#### 9:05 Battery State-of-Health Estimation Using an IMM Kalman Filter and Physics-Based Reduced-Order Cell Models

*Gregory Plett, PhD, Professor, Electrical and Computer Engineering, University of Colorado, Colorado Springs*

Adapting physics-based model parameter values as battery cells age can result in unstable and physically nonmeaningful models. In this presentation, we propose an alternate approach that instead uses an IMM Kalman filter to select the model from a set of pre-computed pre-aged models that best matches the presently observed input/output dynamics of the battery cell under observation. Unlike other approaches, this method guarantees stable and physically meaningful models that track cell parameter values over the lifetime of the battery cell. Simulation results show excellent performance over a wide range of cell aging.

#### 9:25 Model Prediction and Optimization: How to Accurately Estimate Power-Limits for Lithium Ion Batteries Using Physics-Based Models and Realistic Constraints

*Scott Trimboli, PhD, Assistant Professor, College of Engineering & Applied Sciences, University of Colorado, Colorado Springs*

Electric vehicle battery management systems must be able to determine, in real time, the power available that may be sourced by the battery pack. Similarly, in rechargeable packs, it is important to determine how much charge power the pack can accept. Such power limits are used to ensure the pack will not suffer damage by exceeding charge or voltage limits or by exceeding a design current or power limit. This paper describes a method that uses a physics-based dynamic cell model and predictive optimization to accurately compute battery-pack available power.



### 9:45 How Simulation Is Used to Design an xEV Battery Pack Cooling System

**Kaushik Illa, Application Specialist, Electrical Machines, Siemens**

Physically developing and performing trials on new battery compositions and cooling strategies is an expensive and resource intensive process that only large funded organization and laboratories have the facilities to perform successfully. In this talk, we would like to address on how simulation would assist in minimizing the research, analysis, trials and experiments to analyze the behavior of battery systems where we need a strongly coupled resolution of flow, heat transfer and electrochemistry to provide the best possible prediction to maintain the integrity of the system and identifying potential problems at an early stage. In all, it is becoming more imperative to analyze packs and modules through simulation to capture the complexity of a pack and thermal management before a building physical system.

### 10:05 Grand Opening Coffee Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

### 11:00 High Power and Safe Li-metal Batteries Part II: The Forgotten Concept of Three-Phase Boundary

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XNNGI 

**Slobodan Petrovic, PhD, Professor, XNNGI**

The power loss in lithium batteries comes partially from poor electronic conduction and limited active surface area. A new electrode consisting of porous structure and silicon collector is used to enable effective and high-area three-phase boundary between active mass, electrolyte and electronic conductor. (co-author Juergen Garche).

### 11:20 Protection of High-Voltage Battery Systems Against Water Ingress and Condensation

**Michael Harenbrock, Business Development Manager, Mann+Hummel GmbH**

To ensure the required lifetime and to avoid malfunctions in high-voltage battery systems, the battery cells and other system components must be protected from contamination. Battery systems for PHEV and BEV cannot be hermetically sealed as pressure differences between environment and system interior, e.g. caused by uphill / downhill driving or air transport, can lead to plastic deformation or even cracks in the battery system housing, especially in lightweight designs. To avoid this, pressure balancing is required. This is achieved by using a semi-permeable PTFE membrane which lets gases pass, but holds back particles and liquids. Water condensation has to be avoided to prevent corrosion inside the battery system, or even electric shorts. By water vapor adsorption with an air dryer cartridge, the absolute humidity inside the battery system can be reduced, so the Dew Point can be shifted to lower temperatures, thus enabling lower coolant temperatures which are required for efficient liquid cooling, e.g. during fast charging. The poster will illustrate the physical background and current solutions.

### 11:40 Power Pack Unit for Low Voltage Mild Hybrid

**Oliver Gross, Technical Fellow, Energy Storage Systems, Fiat Chrysler Automobiles**

Low voltage (48V) mild hybrid powertrains enable appreciable fuel efficiency benefits for an economical cost. The FCA Belt-Starter-Generator (BSG) powertrain utilizes a Power Pack Unit (PPU), containing a fully integrated battery and DC/DC converter system, for further system optimization. Variations of the PPU have been developed, in order to meet differing use cases and applications, requiring different thermal solutions and integration methods. This presentation will discuss two embodiments of the PPU concept.

### 12:00 pm Multifunctional Energy Storage Composites: Structurally-Integrated Batteries for Lightweight Automotive Applications

**Fu-Kuo Chang, PhD, Professor, Aeronautics and Astronautics, Stanford University**

The talk covers the recent development of the Multifunctional Energy Storage MESC - a multifunctional structural battery which embeds active Li-ion battery materials into high-strength composites together with *in situ* networks of sensors and actuators. The MESC not only can supply electrical power but also serve as a structural element, capable of concurrently carrying

mechanical loads. In addition, the built-in sensor/actuator networks can monitor the health state of both the composite structure as well as the battery on a real-time on-demand basis.

### 12:20 Q&A

### 12:40 Networking Lunch

### 1:35 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

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## CELL ENGINEERING

### 2:35 Chairperson's Remarks

**Mark Verbrugge, PhD, Director, Chemical and Materials Systems Laboratory, General Motors**

### 2:40 Progress and Challenges for the Li-Si System, and a Voltage-Hysteresis Model

**Mark Verbrugge, PhD, Director, Chemical and Materials Systems Laboratory, General Motors**

After recapping recent work on the lithium-silicon (Li-Si) system and the motivation for pursuing Li-Si negative electrodes, we present a model-experiment comparison for the hysteretic behavior observed when using Li-Si electrodes. The model is useful for the simulation of Li-Si based batteries, assisting in battery design and integration endeavors. In addition, for accurate battery state estimation, including electrodes containing both graphite and silicon constituents, a voltage hysteresis model must be employed.

### 3:00 Driving Design Factors for Safe, High Power Batteries for Applications

**Eric Darcy, PhD, Battery Technical Discipline Lead, Propulsion and Power Division, NASA-JSC/EP5**

Previous attempts to obtain the total heat output response during thermal runaway (TR) by accelerated rate calorimetry have left us wondering if the results were relevant to field incidents. There's a suspicion that the total heat output is less than if thermal runaway had been induced quickly. We at JSC have designed a single 18650 TR calorimeter that provides total heat output and discerns those heat fractions. Various cell designs with and without bottom vents are compared.

### 3:20 Rapid Charging Made Practical in Lithium Batteries via Integrated Surface Acoustic Wave Turbulent Electrolyte Mixing to Overcome Diffusion-Limited Charging

**James Friend, PhD, Professor, Mechanical and Aerospace Engineering, University of California, San Diego**

We aim to overcome diffusion limitations in charging liquid electrolyte lithium ion batteries through inclusion of robust, fingernail-sized, and solid-state ~100-MHz surface acoustic wave microdevices that produce turbulent acoustic streaming even through separator structures. These low-power (~10 mW of power per 1 cm<sup>2</sup> of electrode area) devices are fabricated from single crystal lithium niobate, and are compatible with lithium electrochemistry. These same devices also serve as a means to detect morphological changes within the battery, providing a real-time determination of battery status and a significant improvement in safety.

### 3:40 Q&A

### 4:00 Networking Reception in the Exhibit Hall with Poster Viewing

### 5:00 Close of Symposium

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# GLOBAL BATTERY RAW MATERIALS SYMPOSIUM

## Balancing Supply, Demand & Costs for Battery Component Materials

June 4-5, 2018 | Hotel Del Coronado | San Diego, CA

### MONDAY, JUNE 4

#### 12:30 pm Symposia Registration

### GLOBAL BATTERY RAW MATERIALS SUPPLY CHAIN – TRENDS AND ANALYSIS

#### 1:30 Chairperson's Opening Remarks

*Michael Fetcenko, Managing Director, BASF*

#### 1:35 25% by 2025? Lithium and the Electric Vehicle Revolution

*Simon Moores, Managing Director, Benchmark Mineral Intelligence*

The talk will demystify resources, reserves, hard rock production, chemicals, battery grade materials production, and cathode manufacturing. It will also include an update on Benchmark Minerals' Lithium Carbonate and Hydroxide Prices, and Benchmark's Lithium-ion Battery Megafactory Tracker. Benchmark Mineral Intelligence is the world's leading source of price assessments, data, and analysis on the lithium-ion supply chain. It publishes lithium carbonate and hydroxide price assessments each month which is also cited by Bloomberg and Thomson Reuters.

#### 1:55 Lithium-Ion Battery Raw Material Supply and Demand 2016-2025

*Christophe Pillot, PhD, Battery Survey Manager, Avicenne Energy, France*

This presentation includes cathode, anode, electrolyte, and separator demand. It will examine the major component suppliers and include a discussion on price evolution and major technical trends.

#### 2:15 Transport Electrification Trends and the Future Impact on the Ni, Co & Cu Markets

*Denis Sharypin, Head, Market Research, MMC Norilsk Nickel*

This presentation will cover the long-term global nickel supply as well as the production of battery grade nickel along with the key auto trends impacting metals demand and what bottlenecks there are for Ni, Co & Cu demand trends.

#### 2:35 LiB Material Trend Based on Growing xEV Market

*Sachiya Inagaki, General Manager, Industrial Technology Unit, Yano Research Institute, Ltd.*

This presentation will be about a market trend of LiB major 4 materials such as cathode, anode, electrolyte, and separator. The market size of these materials has been growing fast thanks to expansion of the xEV market, and high energy density materials will be a key factor to support this growth. Also, the market presence of Chinese material manufacturers has been rising based on their internal market growth. I will talk about recent and future market trends as to these 4 major materials based on LiB and application market, especially xEV.

#### 2:55 Refreshment Break

#### 3:15 Cobalt: What Is Hype and What Is Reality?

*Michael Insulán, Senior Market Analyst, Marketing Intelligence, Eurasian Resources Group*

Everybody has an opinion on cobalt. But what is hype and what is reality?

#### 3:35 Nickel – From Solution to Solution

*Anne Oxley, Technical Director, Brazilian Nickel*

BEVs numbers are growing to help reduce emissions and improve our environment. The raw materials behind the EV revolution should also be produced with this in mind. Brazilian Nickel's hydrometallurgical process is at ambient conditions (no high temperatures or pressures) and results in dissolved battery metals in sulphate solution. BRN plans to produce nickel hydroxide products with high % nickel for improved transportation; these products are easy to re-dissolve by the cathode manufacturers, but what are the other options and what is the best solution?

#### 3:55 Cobalt - Challenges for a Technology Enabling Metal

*David Weight, President, Cobalt Institute*

This presentation will highlight the value proposition of cobalt. In addition, it will provide an overview of the cobalt market and the major challenges for cobalt in the marketplace while examining how the institute protects market access.

#### 4:15 Why Do We Care about Lithium?

*Emilio E. Bunel, PhD, Senior Analyst, SQM, Chile; Senior Advisor, Physical Sciences and Engineering Directorate, Argonne National Laboratory, Argonne*

From an industrial point of view, lithium has been described as the "oil of the future" or "the new gold rush", and the demand for lithium could exceed supply in 2020 by 25%. At that point, the world is expected to need over 380,000 tons of lithium carbonate and considering that the demand in 2014 was close to 190,000 tons, that is a 100% growth in demand over a six-year period, and much of that growth will come from batteries. In this presentation, we will highlight some of the past and recent activities in SQM to develop our lithium offerings for the industry, including standard lithium uses and energy storage.

#### 4:35 Q&A

#### 5:00 Close of Day

### TUESDAY, JUNE 5

#### 8:30 am Morning Coffee

### ADVANCED BATTERY RAW MATERIALS

#### 9:00 Chairperson's Remarks

*Ahmad Mayyas, PhD, Engineer, Clean Energy Analysis Center, National Renewable Energy Laboratory*

#### 9:05 Focus on Innovation to Lead a Rapidly Growing Technology Based Industry of LiB

*Marina Yakovleva, Global Commercial Manager, New Product and Technology Development, FMC Corporation*

#### 9:25 The Extended Thermal Toolbox: Bridging Fundamental Molecular Architecture and Application Performance Needs

*Kate Johnson, Global Technology Leader, Application Development, Dow Chemical*

This presentation will focus on the balance between rheology, thermal, and mechanical properties as they tie to final application performance needs. Material design and characterization will be discussed incorporating changing industry needs with increased lifetimes, thermal aging, and vibration dampening. This will focus on silicone thermal gap fillers as a base material example to highlight the delicate property balances that must be achieved.



### 9:45 Purity and Performance of Raw Materials to Succeed in the Battery Battle

*Raymond Malcolm Oei, COO, Bait Manganese (PT Bhakti Alam Indonesia Timur); CEO, Stern PT*

Pure, low impurities of metals and environmentally friendly processed raw materials are critical for the quality and performance of lithium-ion and alkaline batteries today. The clear target is to lower the cost per kwh to make it economical. We have to choose the right material balance for the performance required for each particular application. Impurities and density issues have major impacts on the performance, as well as life cycle issues and a direct impact on the corporate image with positive or fatal economic consequences.

### 10:05 Grand Opening Coffee Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

#### 11:00 Electrolyte for High Energy Density LiB

*Le Yu, Director, Research and Development, Guangzhou Tinci Materials Technology Co.Ltd*

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### 11:20 Driving Electromobility through Innovations in NCM and NCA Cathode Materials

*Michael Fetcenko, Managing Director, BASF*

BASF is a leading supplier of high energy cathode active materials to the automotive industry (NCM and NCA), making significant investments in strategic collaborations with metal suppliers and expanding global manufacturing footprint. This presentation will review today's and future product portfolio and innovation roadmap.

### 11:40 A New Class of High Performance, Low Cost, Synthetic Graphite Anode Materials

*Jeremy Schrooten, PhD, Senior R&D Engineer, Energy, Pyrotek, Inc.*

Pyrotek is an innovator in high-temperature processing with over 60 years of experience. Our proprietary furnaces, designed and built by Pyrotek, produce a premium anode graphite at the competitive cost of \$5/kg, manufactured using 100% renewable energy, with very low emissions. Pyrotek's in-house battery materials laboratory builds and tests 18650 cells to evaluate the performance of our material. This presentation reviews actual battery data detailing the performance of this commercially-available anode and its favorable comparison to other anode materials.

## SUPPLY, DEMAND & COST CONTROL

### 12:00 pm Supply Chain Dynamics and How This Will Impact the Price Targets of Li-Ion Industry

*Tom Van Bellinghen, Director of Marketing & Sales, Umicore*

The uncertainty about future supply/demand balances has created an unseen rally in raw material prices, to the extent it starts to put the price down targets of the industry at risk, therefore endangering the demand that created the rally. How to deal with this dilemma? This presentation will look into the strategies one can implement to mitigate these risks.

### 12:20 Q&A

### 12:40 Networking Lunch

### 1:35 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

## SUPPLY, DEMAND & COST CONTROL (CONT.)

### 2:35 Chairperson's Remarks

*Michael Insulán, Senior Market Analyst, Marketing Intelligence, Eurasian Resources Group*

### 2:40 Transparency in Battery Raw Material Prices

*William Adams, Head of Base Metals & Battery Research, Industrial Minerals*

As demand for lithium-ion batteries grows, more transparency is required on the prices of the raw materials that feed the industry, such as lithium, cobalt, graphite, nickel and manganese. Industrial Minerals and Metal Bulletin have been tracking many of these prices for decades. We'll walk you through the recent spikes in lithium and cobalt as well as the fundamental supply and demand scenarios seen in those markets and the other key metals.

## INNOVATIONS IN RECYCLING BATTERY MATERIALS FOR MANUFACTURING

### 3:00 Manufacturing Competitiveness of the Recycled Li-Ion Battery Materials

*Ahmad Mayyas, PhD, Engineer, Clean Energy Analysis Center, National Renewable Energy Laboratory*

This study aims to develop a comparative cost analysis between regions/countries for recycling cathode/anode/electrolyte materials. In addition, detailed supply chain maps will be developed to show the flows of the virgin and recycled materials in the global market, and value chain analysis will be performed to evaluate the value add to the supply chain from recycling LIB cathode/anode/electrolyte materials.

### 3:20 Low Cost Electrode Reclamation

*Steven E. Sloop, President, OnTo Technology*

OnTo has pioneered direct recycling processes for reinstating electrode functionality to well-aged EV battery electrode materials, including native and surface treated lithium nickel cobalt manganese oxide (NCM) as well as mixtures with lithium manganese oxide (LMO, spinel). By leveraging low temperature processing on surface treated electrodes, the successful development of low cost electrode reclamation can reduce recycling energy requirements by 90%, eliminate end-of-life battery costs, and provide a source of electrodes at 30-50% of material cost.

### 3:40 Q&A

### 4:00 Networking Reception in the Exhibit Hall with Poster Viewing

### 5:00 Close of Symposium

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# xEV BATTERY TECHNOLOGY, APPLICATION, & MARKET

June 6-7, 2018 | Hotel Del Coronado | San Diego, CA

## WEDNESDAY, JUNE 6

**8:00 am** Conference Registration and Morning Coffee

### PLENARY SESSION: MARKET EXPANSION OF xEVs AND THEIR BATTERIES

**9:00** Chairperson's Opening Remarks

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

**9:05** Low-Carbon Vehicles: Technology, Incentives, Regulations, and Customer Interest

*Dan Sperling, PhD, Distinguished Blue Planet Prize Professor of Engineering and Environmental Science and Policy, ITS Davis*

**9:25** xEV Implementation – What's Working and What's Not?

*Ted Miller, Senior Manager, Energy Storage Strategy and Research, Ford Motor Company*

**9:45** Toyota's Views on Electrification of Major World Vehicle Markets

*Michael Lord, Executive Engineer, Toyota Motor Engineering & Manufacturing, NA*

**10:05 – 11:00** Coffee Break in the Exhibit Hall with Poster Viewing

**11:00** xEV-Architecture Directions in the Major World Markets

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

**11:30** Key Issues in Promotion of Chinese plug-in Vehicles and the Differences between Chinese NEVs and those in the Rest of the World

*Mark Lu, PhD, Certified Senior Industrial Analyst, Industrial Economics & Knowledge Center (IEK), Industrial Technology Research Institute (ITRI)*

**12:00 pm** Latest Analysis of xEV and LIB Battery Technology and Market Trends

*Takeshi Miyamoto, Senior Vice President, B3 Corporation*

**12:20** Q&A

**12:40** Networking Lunch (Sponsorship Opportunity Available)

**1:25** Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

### BATTERIES FOR xEVs

**2:20** Chairperson's Remarks

*Ted Miller, Senior Manager of Energy Storage Strategy and Research, Ford Motor Company*

**2:25** Continued Glimpses into xEV Batteries on the Market – AVL Series Battery Benchmarking

*Wenzel Prochazka, Battery Manager, Battery Benchmarking Program, AVL List GmbH*

The program provides a database for objective comparison in technical attributes as well as in engineering methodology with market competitors for clear system target definition of high performing, reliable and safe batteries. 270 different criteria are evaluated through AVL benchmarking metrics displayed in 8 high level attributes. The found integrated system

performance values in cell, mechanical and electrical system are pointed out to support current and future development programs. Example vehicles are the Mitsubishi Outlander, Tesla Model X and Chevrolet Bolt.

**2:45** Silicon Anode Development for High-Energy, Long-Cycle-Life Lithium-Ion Cells

*Sujeet Kumar, PhD, CEO, ZenLabs Energy*

Silicon is a promising next-generation anode material to enable electric vehicle with long range. However, its cycle life is limited due to large volume changes and pulverization during charge-discharge. We present lithium ion cells for electric vehicles based on silicon electrodes having high active content (>60%) that has shown to cycle over 700 times in a large format cell. Energy, Power & Cycling behavior under various duty cycles will be presented. The cells with silicon electrode also exhibit excellent fast charge capability.

**3:05** How the Need for Fast Charging in E-Mobility Drives Development for New High Efficient Thermal Conductive Materials

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*Terry Solberg, AE/AE GTM Thermal, AE, Henkel*

**3:25** Refreshment Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

**4:20** What is EV Battery Technology Likely to Look Like in 2025?

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

While the fundamental cell technology and manufacturing processes have barely changed since their 1991 market introduction, Li-ion batteries have been on a continuous path of technology improvement and cost reduction. Their compelling characteristics have made them the technology of choice for most applications including hybrid and electric vehicles. This presentation will explore how much further the technology can evolve and whether or not a shift to a different chemistry or a drastic change in electrolyte, anode, or cathode composition are feasible in the next 8-10 years.

**5:00** Q&A

**5:20** Networking Reception in the Exhibit Hall with Poster Viewing

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**6:30** Close of Day

## THURSDAY, JUNE 7

**8:15 am** Continental Breakfast Roundtable Discussions

Join your colleagues and fellow delegates over breakfast for a focused, informal discussion moderated by a member of our speaking faculty. A small group format allows participants to meet potential collaborators, share examples from their own work and discuss ideas with peers. Visit our website to see the full listing of topics and moderators.

### BATTERY LIFE AND RELIABILITY

**9:30** Chairperson's Remarks

*Bob Taenaka, Technical Specialist, Battery System Development at Ford Motor Company*

**9:35** xEV Batteries For Service Replacement Needs 10+ Years After the End of Production

*Bob Taenaka, Technical Specialist, Battery System Development at Ford Motor Company*

xEV batteries must be designed not only to meet warranty and operational design life targets that are often 8-10 years, but provision must be made to have service replacement batteries available for as long as 10-15 years after



the end of xEV battery and vehicle production. This paper describes the technical needs of a service replacement battery, as well as strategies for making them available for 10+ years after the end of battery cell and battery pack mass production.

## 9:55 Wireless Charging of Electric Vehicle Batteries for Enhanced Safety, Longevity, and Economics

*Chris Mi, PhD, Professor and Chair, Electrical and Computer Engineering, San Diego State University*

EV battery charging with wireless power transfer technology, which provides enhanced safety, reduce cost, improve reliability and longevity.

## 10:15 Battery Integration, Safety and Life

*Daniel Le, PhD, Lead Systems Engineer, Johnson Controls*

## 10:35 Coffee Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

## 11:35 Reliable Batteries for Extreme Usage - Meeting the Challenge of Longer Life, Expanded Temperatures, and Stringent Requirements

*Takuya Miyashita, Honda Motor Co., Ltd.*

Lithium-ion batteries are continually being asked to do more and cost less. As an example, 48V MHEV systems originally tasked with achieving fuel economy targets under standard conditions are now being asked to do much more. Power demands for charge and discharge are ever-increasing, and new functions such as cold cranking are demanded by vehicle manufacturers seeking to eliminate the lead-acid battery. Additionally, temperature ranges are widening to ensure usability by customers in extreme climates. In this presentation, we consider changes in requirements to 48V and high-voltage battery systems, and how that impacts our mission of developing highly reliable batteries. Emerging requirements, novel modeling techniques, and design strategies will be presented.

## 11:55 Estimation of Probable Distribution of Users' Li-Ion Battery Performances

*Brian Sisk, Vice President, Cell Product Development, A123 Systems LLC*

The presentation addresses a method of estimating probability distribution of Li-ion battery performances. Statistical simulation of various big data by means of Honda's vehicle, battery and battery degradation models enables Honda to estimate distribution of Li-ion battery capacities for Honda's hybrid electric vehicles in actual users' usage conditions. This method helps Honda to estimate probability distribution of battery performances after degradation and optimally design the performance and cost of Li-ion batteries for target markets.

## 12:15 pm Application of Robust 'Real World' Usage Cases to Predict Battery Life

*Valentina Gentili, PhD, Advanced Battery TS, Jaguar Land Rover*

OEMs have the responsibility to ensure performance and durability of their electric vehicles. Therefore, it is paramount to have a good understanding of the factors and mechanisms that play a role in the battery performance degradation. This presentation will describe the process followed to capture user requirements and the development of testing conditions that are as close

as possible to 'real world' use to assess the implications that such factors may have on the battery performance over time.

## 12:35 Q&A

## 12:50 Networking Lunch

## 1:40 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

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## CHARGING & INFRASTRUCTURE

## 2:25 Chairperson's Remarks

*Kevin Konecky, Battery Systems Consultant, Total Battery Consulting, Inc.*

## 2:30 Industry Trends in Charging and Infrastructure

*Kevin Konecky, Battery Systems Consultant, Total Battery Consulting, Inc*

Lithium-ion battery systems are an enabling technology in the propagation of xEVs with longer range and higher-energy-density batteries, further enabling public acceptance are convenient and time-effective charging options. This presentation will review a large number of xEVs currently in production and discuss trends and diversity in the subsystem design choices that were implemented in each production system including charge capabilities. Different charging protocols and standards across the globe will be discussed with trends analyzed, as well as improvements to user convenience including faster DC-charging and wireless charging.

## 2:50 How Do We Power Millions of EVs?

*Jason Appelbaum, CEO, EverCharge*

With many new electric vehicles slated for 2020 and beyond cities, consumers, and OEMs must consider how they plan to power these vehicles. Investing in a massive infrastructure overhaul will be time consuming and expensive. However, by leveraging smarter dynamic charging technology we can power more vehicles by simply using power more efficiently.

## 3:10 Refreshment Break

## 3:30 Charging Infrastructure Controls and Technical Evaluations

*Jordan Smith, P.E., Senior Engineer, Emerging Technologies, Grid Technology and Modernization, Southern California Edison*

This presentation will provide an overview of SCE charging infrastructure technical evaluations, installation, use characteristics, and controls.

## 3:50 Ultra Power Dynamic Charging System for EV (450 kW)

*Takamitsu Tajima, Chief Engineer, EV Development, Honda R&D Co Ltd.*

## 4:10 Q&A

## 4:30 Closing Remarks

## 4:40 Close of Conference

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# EV TECHNOLOGY FOR SPECIALTY TRANSPORTATION

## High-Energy Battery Development for Next Gen Bus, Truck & Bike Applications

June 6-7, 2018 | Hotel Del Coronado | San Diego, CA

### WEDNESDAY, JUNE 6

#### 8:00 am Conference Registration and Morning Coffee

#### PLENARY SESSION: MARKET EXPANSION OF xEVs AND THEIR BATTERIES

See page 3 for full abstracts

##### 9:00 Chairperson's Opening Remarks

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

##### 9:05 Low-Carbon Vehicles: Technology, Incentives, Regulations, and Customer Interest

*Dan Sperling, PhD, Distinguished Blue Planet Prize Professor of Engineering and Environmental Science and Policy, ITS Davis*

##### 9:25 xEV Implementation – What's Working and What's Not?

*Ted Miller, Senior Manager, Energy Storage Strategy and Research, Ford Motor Company*

##### 9:45 Toyota's Views on Electrification of Major World Vehicle Markets

*Michael Lord, Executive Engineer, Toyota Motor Engineering & Manufacturing, NA*

##### 10:05 – 11:00 Coffee Break in the Exhibit Hall with Poster Viewing

##### 11:00 xEV-Architecture Directions in the Major World Markets

*Menahem Anderman, PhD, President, Total Battery Consulting, Inc.*

##### 11:30 Key Issues in Promotion of Chinese plug-in Vehicles and the Differences between Chinese NEVs and those in the Rest of the World

*Mark Lu, PhD, Certified Senior Industrial Analyst, Industrial Economics & Knowledge Center (IEK), Industrial Technology Research Institute (ITRI)*

##### 12:00 pm Latest Analysis of xEV and LIB Battery Technology and Market Trends

*Takeshi Miyamoto, Senior Vice President, B3 Corporation*

##### 12:20 Q&A

#### 12:40 Networking Lunch (Sponsorship Opportunity Available)

#### 1:25 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

#### SPECIALTY EV MARKET DEMAND

##### 2:20 Chairperson's Remarks

*Anil Paryani, PhD, CTO, BTC Power; Founder, Auto Motive Power, Inc.*

##### 2:25 Specialty EV Market Overview and Related Battery Demand

*Luke Gear, PhD, Technology Analyst, IDTechEx*

This presentation will provide an assessment of the state of market development of specialty electric vehicles, focusing on electric buses, electric trucks, electric mining vehicles, two wheelers, and electric marine ships and vessels. We will provide an overview of the types and size of batteries (chemistry) that these types of vehicles are using. We will provide a 10 year

forecast of these electric vehicle categories and a corresponding forecast of the battery demand for these categories.

##### 2:45 Heavy Duty EV Trucks and Buses - Industry Overview

*Nate Baguio, Vice President, Lion Electric Co.*

This presentation will examine what is coming up next and why the industry is growing and changing so rapidly. In addition, the environmental, social, and economic impacts of this growing/changing industry will be presented.

##### 3:05 Why and How to Perform Electrical Safety Tests on EV Battery Packs

*Jorel Townsend, Safety/LED ATE Sales Manager, Chroma Systems Solutions, Inc.*

An overview of EV battery pack electrical safety testing during manufacturing process.

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##### 3:25 Refreshment Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

#### OEM APPLICATION-DRIVEN DEVELOPMENT

##### 4:20 Lightweight Electric Vehicle Market

*Sam Jaffe, Managing Director, Cairn Energy Research Advisors*

This presentation will explore the market for light electric vehicles, segmented by scooters, ebikes, etuk (i.e. three-wheeled taxi vehicles), and neighborhood vehicles. The market size and ten year forecast for each market will be given, both for vehicle units and batteries sold into the market. Additionally, new trends in batteries for the LEV market will be discussed.

##### 4:40 Electric Heavy Duty Goods Transport Trucks

*Paul B. Scott, PhD, Vice President, Advanced Technologies, Engineering, TransPower*

Electric Class 8 trucks are increasingly competitive for limited range applications such as port drayage, yard tractors and heavy lift vehicles. This paper will describe E-trucks being employed at ports, warehouses, and for delivery distances of under 100 miles. With ZEV requirements being imposed for goods movement in large cities and ports, major OEM vehicle suppliers are increasing offering an electric zero emission alternative as part of their product line. The drive-train design and battery energy storage systems appropriate for these applications will be described in detail.

##### 5:00 Q&A

##### 5:20 Networking Reception in the Exhibit Hall with Poster Viewing

##### 6:30 Close of Day

### THURSDAY, JUNE 7

##### 8:15 am Continental Breakfast Roundtable Discussions

Join your colleagues and fellow delegates over breakfast for a focused, informal discussion moderated by a member of our speaking faculty. A small group format allows participants to meet potential collaborators, share examples from their own work and discuss ideas with peers. Visit our website to see the full listing of topics and moderators.

#### OEM APPLICATION-DRIVEN DEVELOPMENT

##### 9:30 Chairperson's Remarks

*Luke Gear, Technology Analyst, IDTechEx*



## 9:35 FEATURED PRESENTATION: The Development and Broad Applications of Energy Storage System at BYD

*John Zhang, PhD, Senior Technical Executive Officer, Asahi Sasei Separator; Senior Technical Advisor, BYD EDV Batteries, China*

As the largest EDV producer, we are also rapidly developing an ESS system, as one of the pioneers, with large scale commercial Li-ion. As of today, 2017, we have established a 3GW solar energy system and >300MWh ESS worldwide. In this paper, we will focus on the three key technology R&D in: PCS (conversion), Li-ion Batteries, and BMS. We will also link these technologies with real large scale applications (no "if" and "predictions").

## FAST CHARGING SYSTEM ENGINEERING & INFRASTRUCTURE DEVELOPMENT

### 9:55 Implementation of LTO Batteries for Fast Charging E-Buses and Trolleybuses - Practical Results

*Bartek Kras, PhD, CTO, R&D, Impact Clean Power Technology S.A.*

Implementation results of LTO based battery packs in a fleet of 15 e-buses and trolleybuses will be presented in this paper. We have developed a fast charging LTO solution for pure e-buses and trolleybuses. Design consideration and field test results will be presented in the paper.

### 10:15 Making Workplace Charging Work

*Patrick Kelly, Program Manager, Implementation, EDF Renewable Energy*

Workplace charging is critical to future grid stability in regions with high solar penetration. The flexible load from EVs while parked at work can align perfectly to the variable generation of solar. EDF Renewable Energy can clearly identify how to turn this philosophy into practice by integrating on-site solar, smart-charging, and a stationary battery into an energy management system resulting in an optimized solution that lowers energy costs for both the employer and the employee.

### 10:35 Coffee Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

## INNOVATIONS IN ALTERNATIVE HYBRID VEHICLES AND GRID-SCALE ENERGY STORAGE

### 11:35 Battery and Supercapacitor Energy Storage Systems for PHEVs

*Andrew F. Burke, PhD, Institute of Transportation Studies, University of California, Davis*

The use of supercapacitors in the electric driveline of plug-in hybrid vehicles (PHEVs) is analyzed from the design, performance, and economic points-of-view. The supercapacitors are envisioned to be part of the motor and electronics package and thus the same electric drive package can be combined with batteries of different energy storage capacity (kWh) as needed to meet the specific all-electric range of the vehicle. Both light-duty and heavy-duty applications are considered.

### 11:55 Fuel Cell Electric Vehicles – A California Status Report

*Rob Del Core, Director, Fuel Cell Power Systems & Hydrogen Fuel Infrastructure, Hydrogenics USA, Inc.*

Light duty vehicles, freight and goods movement, clean ports, transit buses, and rail are all potential mobility markets for hydrogen-fueled fuel cell and for battery electric zero emission drive trains. These are the zero emission solutions needed to achieve California's air and greenhouse gas goals. Current and potential markets will be explored with a message of how they each have their role, even while they compete for resources and market attention.

### 12:15 pm Stationary Batteries Are Moving: How Grid-Scale Storage Has Achieved Momentum

*Hareesh Kamath, Senior Program Manager, Electric Power Research Institute (EPRI)*

The deployment of grid-scale energy storage projects, especially those based on lithium-ion batteries, is rapidly accelerating. In the near future, grid-scale storage is likely to find regular use for enhancing grid reliability and resiliency, as well as aiding in the integration of renewable energy technology. The

success of storage is dependent on the industry addressing some of the continuing gaps in storage implementation. This presentation will focus on the technological, social, political and economic factors that have accelerated storage deployment as well as challenges that may impede growth in the future.

### 12:35 Q&A

### 12:50 Networking Lunch

### 1:40 Dessert Break in the Exhibit Hall with Poster Viewing (Sponsorship Opportunity Available)

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## COMMERCIAL xEVs AND THEIR BATTERY SYSTEMS

### 2:25 Chairperson's Remarks

*Boryann Liaw, PhD, Department Manager, Energy Storage and Advanced Vehicles, Clean Energy & Transportation Division, Idaho National Laboratory*

### 2:30 Enabling Competent Electrical Vehicles

*Wenjuan Mattis, PhD, Vice President, Technology, Microvast, Inc.*

In this talk, we will disclose the reason behind each cell component (cathode, anode, binder, and electrolyte) on the safety of lithium battery. We will also describe a new nonflammable electrolyte that not only is nonflammable in the liquid phase but also during venting. We also describe the role of a novel aramid separator that has a very high shrinking temperature tolerance of over 300°C.

### 2:50 Life Cycle Assessment of Lead Batteries

*Boris Monahov, PhD, Program Manager, Advanced Lead-Acid Battery Consortium (ALABC) – a program of the International Lead Association (ILA)*

*Alistair Davidson, PhD, Products and Sustainability Director, International Lead Association*

Life cycle assessment (LCA) is becoming an increasingly important and wide spread tool for determining the environmental footprint of products. This presentation will discuss a new project of the International Lead Association (ILA) which will use LCA to calculate the environmental footprint of lead batteries in Europe and North America. This will cover the whole lifecycle of a lead battery, from mining and primary and secondary lead production, to battery manufacture and use through to end of life recycling.

### 3:10 Refreshment Break

### 3:30 Advanced Energy Storage Solutions for the North American Hybrid and Electric Bus Market

*Tomasz Poznar, Vice President, Transportation, EnerDel, Inc.*

In this presentation, Mr. Poznar will discuss EnerDel's re-emergence as a major lithium-ion battery supplier in the North American market through the development and introduction of an advanced battery solution specifically targeted for the hybrid bus market. In addition, Mr. Poznar will introduce EnerDel's next generation of energy cells, modules, and packs that are targeted for the fully electrified bus and industrial market applications.

### 3:50 Electrical Power Platforms & Powertrains for 21st Century Workhorses

*Gary Dannar, CEO, DD Dannar, LLC*

Mobile Power Station® (MPS) is the first in a new class of electric work and energy platforms providing self-propelled power for emergency response and multi-functional utility. MPS can work year-round in all areas of infrastructure, maintenance, agriculture, and disaster response, and with over 200 kW of onboard energy, the MPS offers significant supplemental off-grid export power when needed. The commercialization of heavy-duty electric work equipment focusing on the MPS and its role as a universal work solution for first responders and public works will be presented.

### 4:10 Q&A

### 4:30 Closing Remarks

### 4:40 Close of Conference



## PRICING AND REGISTRATION INFORMATION

### ALL ACCESS

(Includes Access to All Tutorials, Partnering, Symposia, and Conferences. Note: some events run in parallel.)

	COMMERCIAL	ACADEMIC, GOVERNMENT
Advance Registration Rate Until May 4	\$2299	\$1949
Late Registration Rate after May 4	\$2499	\$2099

### INDIVIDUAL SYMPOSIUM

(Includes Access to One Symposium, Excludes Conferences, Partnering, and Tutorials. Moving between presentations going on at the same time is allowed.)

Advance Registration Rate Until May 4	\$1249	\$999
Late Registration Rate after May 4	\$1349	\$1099

### INDIVIDUAL CONFERENCE

(Includes Access to One Conference, Excludes Partnering, Symposia and Tutorials. Moving between presentations going on at the same time is allowed.)

Advance Registration Rate Until May 4	\$1749	\$1449
Late Registration Rate after May 4	\$1849	\$1549

### TRAINING SEMINARS

(Includes Access to Training Seminar Only, Excludes Conferences, Symposia, Partnering, and Tutorials.)

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Advance Registration Rate Until May 4	\$999	\$1749	\$799	\$1449
Late Registration Rate after May 4	\$1099	\$1849	\$899	\$1549

### PARTNERING

(Includes Access to Partnering Only, Excludes Conferences, Symposia and Tutorials. Moving between presentations going on at the same time is allowed.)

Advance Registration Rate Until May 4	\$999	\$799
Late Registration Rate after May 4	\$1099	\$899

### TUTORIAL

(Includes Access to Tutorials Only)

One Tutorial	\$300	\$300
Two Tutorials	\$550	\$550

#### ADDITIONAL REGISTRATION DETAILS

##### Want to Register by Phone?

Contact our Registration department at 781-972-5400 or Toll-free in the US 888-999-6288.

#### DISCOUNTS

##### Groups of 4 or More

(must register at the same time)

☐ 15% discount

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Please see website's poster page for more information about posters at AABC.

Twitter, LinkedIn, Facebook or any other promotional discounts cannot be combined.

#### June 4

##### 8:00 - 10:00 am

**TUT1:** The Rechargeable Battery Market: Value Chain and Main Trends 2017 - 2027

**TUT2:** Recent Advances in Solid State Electrolytes for Energy Storage

**TUT3:** Improving the Energy Density of Batteries with Silicon-Based Anodes

##### 10:30-12:30 pm

**TUT4:** Innovations in Packaging and

New Regulatory Requirements For Transportation of Batteries

**TUT5:** Materials for Next Generation Batteries

**TUT6:** The Global Electrolyte Market: Competitive Landscape and Market Opportunities

##### 8:00-5:00 pm

**PS1:** Automotive Partnering Summit

#### June 4-5

**S1:** Battery Chemistries for Automotive Applications

**S2:** Battery Engineering for Automotive Applications

**S3:** Global Battery Raw Materials

#### June 6-7

**C1:** xEV Battery Technology, Applications, and Market

**C2:** EV Technology for Specialty Transportation

**TS1:** Lithium-Ion Battery Cell and Pack Technology

**TS2:** Battery Safety & Abuse Tolerance Validation

How to Register: **AdvancedAutoBat.com/US**

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