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**LEAD-BASED**



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# Welcome!

Dear Colleague,

I am pleased to share with you the excitement about AABC Europe 2020, and to invite you to join us in Wiesbaden, Germany, this coming January. Join a global audience of battery technologists from leading automotive OEMs and their key suppliers for a must-attend week exploring development trends and promising technologies of vehicle electrification.

New EVs from dedicated platforms will start appearing in the European market in 2020 with large volume market expectations. The market will test the ability of European automakers to expand electrifications and meet aggressive government CO2 reduction targets. Key to market success is battery technology—performance, cost, life reliability, and safety where automakers are targeting continuous notable improvement. This chain of events has created significant opportunities for the xEV supply chain, but with those come notable risks of meeting aggressive OEM cost/performance targets.

We at AABC understand the opportunities and challenges and have created a program that will help you follow the trends, the issues, and the directions adopted by key players.

In addition to our renowned xEV battery sessions—which cover the xEV and xEV-battery markets, batteries for low- and high-voltage hybrids and full electric vehicles, and battery durability in automotive applications—the program will also feature sessions on:

1. Li-ion battery materials and chemistry and beyond
2. Li metal battery chemistry
3. Raw material supply, future cost and availability
4. Recycling technology and logistics
5. Lead-acid battery technology and application advances
6. Battery safety, thermal runaway, and cell and battery engineering
7. Digital twins, machine learning, and data analytics
8. Batteries for specialty, light, off-road vehicles, and public transportation

This is a pivotal time for the industry, with second-generation products hitting the market, and roadmaps for third-generation products being drawn—with expectations for considerable volume expansion.



**Menahem Anderman**  
Conference Chair

## Top Reasons to Attend

- » Learn first-hand about the technical and business directions from major automakers currently active in the European market
- » Hear key global market outlook data on the forecasted consumption trends for China, Japan, Korea, Europe and the United States
- » Meet leading energy storage technologists from all automakers active in the European market
- » Discuss fast-charging solutions coming to the market to support electrification goals for the coming decade
- » Get an in-depth international overview of the lead industry including current trends, competitive analysis and examination of the key players and their strategies for market growth
- » Discover the latest technological advancements in high specific energy batteries with long cycle life and low cost
- » See how key players are overcoming challenges to commercialization for the specialty EV battery market while assessing consumer demand and competing technologies
- » Understand the many facets of the international battery raw materials market, including advances in mining and processing with an emphasis on sourcing and cost control strategies by manufacturers
- » Network at the largest international gathering of advanced energy storage technology developers and integrators in Europe

Join us in Wiesbaden to start 2020 well-informed!

## Event-At-A-Glance

Sunday 12 January	Monday - Tuesday 13 January - 14 January	Wednesday - Thursday 15 January - 16 January
<b>INTERACTIVE TUTORIALS</b>	<b>SYMPOSIA</b>	<b>CONFERENCES</b>
Tutorials: See page 3	 Symposium 1 CHEMISTRY	 Conference 1 HYBRID & ELECTRIC VEHICLES
	 Symposium 2 ENGINEERING	 Conference 2 SPECIALTY TRANSPORT EVs
	 Symposium 3 LEAD-BASED	 Conference 3 RAW MATERIALS
	 Symposium 4 RECYCLING	
	Dinner Tutorials: See page 3	

## SUNDAY, 12 JANUARY

## Afternoon Tutorial | 15:00 - 17:00

**TUT1: The Rechargeable Battery Market: Value Chain and Main Trends 2018-2028**

This tutorial will present the 10-year automotive market forecasts from Avicenne and other analysts (micro|Hybrid|P-HEV|EV). Other coverage will include car makers' strategies and 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 2018-2028 will be discussed.

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

## Concurrent Dinner Tutorials | 18:00 - 20:00

**TUT2: Cell Engineering – How Battery Calorimetry Can Aid Battery Research**

This tutorial will discuss the role of calorimetry when it comes to battery research and the benefits of battery calorimetry. Quantitative measurement of thermal data, such as Quasiadiabatic Cycling and Isoperibolic Cycling will be covered as well as abuse tests in the field of battery calorimeters including the HWS test.

*Carlos Ziebert, Head of the Calorimeter Center, Thermophysics and Thermodynamics Group, Karlsruhe Institute of Technology (KIT)*

## MONDAY, 13 JANUARY

## Concurrent Dinner Tutorials | 18:30 - 20:30

**TUT4: Managing and Understanding the Risks of Li-Ion Battery Safety**

A wide variety of stresses and abuses of Li-ion cells can result in safety events involving significant, and sometimes even violent, energy release and thermal runaway. This tutorial provides a framework for a better understanding of how these safety events occur, how lithium-ion batteries respond to various stresses/abuses, how various stresses can lead to thermal runaway, and why differing stresses produce challenges to assessment of safety characteristics of Li-ion cells. For major types of stress/abuse, a flow chart identifying key process steps and characteristics of cell response helps provide important insights regarding similarities and important differences of various types of safety-related failures. A systematic understanding of similarities and differences between most types of stresses helps provide important perspective regarding management of Li-ion battery safety, as well as appropriate safety testing.

*Brian Barnett, PhD, President, Battery Perspectives LLC*

**TUT5: Lithium-Ion Cell Design**

This tutorial provides an overview of lithium-ion cell design. Common cell designs are discussed with emphasis on pros and cons including safety aspects. Major cell chemistries (NCA, NCM532, NCM622, NCM811 versus graphite or graphite/silicon lends) are considered in terms of energy density. Cell components (positives, negatives, electrolytes, separators, collectors, packages) are covered as well as design principles (porous electrodes, tab effect, balancing, porous electrode design) and approaches for analyzing aging and abuse.

*Bob Spotnitz, President, Battery Design LLC*

**TUT6: Materials for Next-Generation Batteries**

This tutorial will cover the materials and performance challenges for next-generation batteries for electric vehicles, the electricity grid and electric flight. The needs and use cases for storage in these three applications will be analyzed. The possibilities for advanced lithium-ion batteries with lithium metal anodes and solid-state electrolytes, for beyond lithium-ion batteries including lithium-sulfur and lithium-oxygen conversion cathodes and multivalent intercalation batteries with magnesium, calcium and zinc anodes for vehicles will be presented. Redox-active polymer ("redoxmer") batteries for the electricity grid will be discussed. 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.

*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 at Chicago*

**TUT7: Solid-State Batteries – Solid Electrolytes, Electrode Interfaces, and Full Cells**

This tutorial will give an overview on the status of solid-state battery development. The scientific basis for solid-state batteries will be explained in detail. The different types of solid electrolytes (oxides, sulfides, polymers) will be introduced, and recent trends will be highlighted.

*Jürgen Janek, PhD, Professor, Director, Center of Materials Research, Justus-Liebig University & BELLA, Institute of Nanotechnology, Karlsruhe Institute of Technology, Germany*

## TUESDAY, 14 JANUARY

## Concurrent Dinner Tutorials | 18:00 - 20:00

**TUT8: Lithium-Ion Battery Raw Materials Markets: Supply and Demand Outlook and Pricing Evolution**

This tutorial analyzes how the lithium, cobalt, and nickel supply chains need to develop to keep up with the rapid growth in demand for lithium-ion batteries for use in electric vehicles (EV) and energy storage systems (ESS). The market is already growing at a rapid rate, and that is before EVs and ESSs have become mainstream. As they become mainstream, the upstream supply chain will struggle to keep up with year-after-year of extremely high-demand growth. What is more, as the lithium and cobalt markets grow from relatively small niche markets to mainstream markets that multinational industries rely on to feed the electrification era, the supply chain is going to need the benefit of a global pricing system that will facilitate investment in new supply and the flow of battery raw materials through the supply chain. Fastmarkets's experience in price reporting and long history of working with futures exchanges will provide insight into how this is likely to unfold.

*William Adams, Head of Battery Research, Fastmarkets Research*

**TUT9: Li-Ion Cell Design and Manufacturing: Processes, Equipment and Quality Control**

This tutorial will begin with an overview of Li-ion cell design for performance and manufacturability, including contrasting the performance and characteristics of commonly used materials. The tutorial will then lead into a detailed review of Li-ion cell manufacturing from incoming raw materials through final cell formation, aging and shipment. Manufacturing processes, equipment and production line costs will be contrasted for cylindrical, prismatic and pouch cells. Samples of commonly used cell components will be displayed. Quality control procedures will be described for each step of the cell manufacturing process, including a discussion on how to optimize cell performance, yields and safety. Attendees can expect to leave this tutorial with an understanding of how commercial Li-ion cells are designed and produced.

*James Kaschmitter, CEO, SpectraPower*

**TUT10: Fast Charging**

This tutorial will cover fast-charging strategies. How to use physical battery models to assess anode potential and decrease lithium plating will be discussed. Different models will be compared and contrasted, and you will learn how to "reality check" these strategies to figure out which will work best on real cells and predict how they will perform and age as well as how long it will take them to charge.

*Michael Schönleber, PhD, CTO, Batemo GmbH*

**TUT11: Battery Safety and Abuse Tolerance Validation**

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 shouldn't forget the safety – as an example the Samsung Galaxy Note 7 battery safety case. Unfortunately, we face daily safety events with injuries and severe damage. This tutorial 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.

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



# LITHIUM BATTERY CHEMISTRY

## Advancements in Lithium-Ion and Beyond

**MONDAY, 13 JANUARY****8:00 Symposium Registration & Morning Coffee****LITHIUM-ION****9:30 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*

**9:35 Cathode Market Expansion: Challenges and Opportunities**

*Paul Spurr, PhD, Manager Applied Technology, Umicore*

EV penetration of somewhere between 1 and 2 % has turned cathode landscape upside down. How to prepare for the 100\$/kWh, when price parity with ICE will be reached and the real growth will start? Decreasing cost, increasing energy density, improve product purity, ensuring raw material availability and upstream mining investments, while guaranteeing ethical and environmental standards, all at a lower CO2 footprint: a lot of balls to keep in the air at the same time.

**9:55 Advanced Coating Technologies to Boost Performance of High-Nickel Cathode Active Materials (CAMs)**

*Hartmann Leube, PhD, Senior Vice President, Technology, RCN New Technologies, BASF AG*

E-mobility applications, with their need for high-energy density cells, require cathode material manufacturers to push the nickel content of CAMs to higher levels. It is known that because of the higher nickel content, cell degradation phenomena, caused by surface-electrolyte interaction, become more severe. BASF is developing advanced coating technologies for CAMs, e.g. Atomic Layer Deposition (ALD), to meet future customer requirements. Recent progress and status will be presented.

**10:15 eLNO<sup>®</sup>: Next-Generation High-Energy Low-Cobalt Cathode Materials for Greater Stability and Safety**

*Eva-Maria Hammer, PhD, Product Innovation Manager, Battery Materials, Johnson Matthey*

Through materials and process engineering, JM has brought a world-leading high-nickel, low-cobalt offering to the market: eLNO. JM's rapid customisation model continues to push the energy, stability, and safety performance of these materials even higher, whilst further reducing cobalt content. In this talk, we aim to demonstrate the competitive advantage of eLNO and provide an insight into JM's strength of developing and tailoring material performance for the fast-paced automotive industry.

**10:35 Networking Coffee Break****11:05 Silicon in Commercial and Near-Commercial Lithium Ion Batteries: State of the Art and Perspectives on Higher Silicon Loadings Enabled by Electrolyte Additives**

*Egbert Figgemeier, PhD, Professor, Helmholtz Institute Münster, Forschungszentrum Jülich*

Silicon plays a prominent role in boosting the capacity of lithium-ion batteries, which is reflected by the fact that commercial 18650 cells already contain electrodes made of silicon/graphite blends. The presentation will give an overview of the current state-of-the-art of silicon in commercial cells. Moreover, results of experimental cells with high loadings of silicon and innovative electrolyte additives will be presented.

**11:25 On The Way to Silicon-Based Anode Materials – Beyond Cycle Stability**

*Stefan Haufe, PhD, Director LIB Application Technology, Consortium für elektrochemische Industrie, Wacker Chemie AG*

The challenges related to the huge volume change of silicon during lithiation still hamper its use as main anode material in lithium-ion batteries. Material concepts both addressing mitigation on the electrode as well as on the materials level are under investigation. Besides cycle stability and further electrochemical properties, applicability in existing production equipment and economic attractiveness are in the focus of these developments.

**11:45 Lithium Ion Battery Separator Selection for EV Application: Brief Discussion on Benefits of Base & Different Coated Separators**

*Kelvin Wu, MBA, Director, Overseas Business, SEMCORP*

To achieve high safety standards for high energy density chemistry, SEMCORP has developed advanced functional coating technologies for LIB, such as Ceramic, PVDF, AFL, and Aramid coatings, to enable engineers to design safer batteries with long cycling performance. This presentation discusses base separator and coating selection for EV batteries.

**12:05 Q&A****12:30 Networking Lunch****LITHIUM-ION****13:55 Chairperson's Remarks**

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

**14:00 Tailor-Made Electrolyte Solutions for Advanced Lithium-Ion Batteries**

*Ralf Wagner, PhD, CEO, E-Lyte Innovations GmbH*

In recent years, the lithium-ion battery has conquered many new applications such as automotive, medical or aviation. Each application places different demands on the battery. Due to the different materials used, not all requirements can be met by one battery setup. Therefore, an adjustment of the battery is required to address each application with maximum efficiency. In this regard, the development of tailor-made electrolytes is a key strategy for success.

**14:20 Confronting the Challenges of Silicon-based Lithium Ion Full-Cells by Design of Effective Electrolyte Additives with Synergistic Impact**

*Tobias Placke, PhD, Head of Division "Materials", University of Münster, MEET Battery Research Center*

A major challenge for the practical application of Si-based negative electrodes in lithium ion full-cells is the continuous depletion of electrolyte and loss of active lithium. In this talk, we present novel approaches for the design of electrolyte additives with synergistic functional moieties, resulting in an effective solid electrolyte interphase (SEI) formation. Further, we will give new insights into the systematic electrochemical characterization of electrolyte additives under commercially relevant conditions.

**14:40 Coatings and Materials Enabling Performance, Manufacturability, and Safety for EV Batteries**

*Calum Munro, Senior Scientist Science & Technology, PPG*

Electric vehicle growth is demanding unique solutions for lithium-ion batteries and electrified drivetrains, including full-battery electric vehicles that provide increased performance and range for broader consumer acceptance. To enable this, higher-capacity EV batteries are being designed with increased energy density and higher voltage. In addition, scale is driving high-throughput, automated coating and material solutions for improved productivity and cost. Together, these factors are increasing demand for lightweight, environmentally and manufacturing friendly functional solutions for battery pack sealing, thermal management, and safety performance. PPG offers a unique range of solutions for these new demands in EV battery design and production.

**15:00 Talk Title to be Announced**

*Surya Moganty, PhD, CTO, NOHMs Technologies Inc.*

**15:15 Refreshment Break****ELECTROLYTES****15:50 Chairperson's Remarks**

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

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**16:05 Li-Metal Batteries with Liquid Electrolytes: History and Outlook***Klaus Brandt, PhD, Consultant, Lithium Battery Consulting*

Rechargeable batteries with Li-metal anodes have a more than 40-year history. However, Li-ion cells with carbon anodes displaced them due to better cycle life and safety. However, with Li-ion reaching its limits as far energy density is concerned and with new electrolytes being developed, the Li-metal anode becomes a potential next technology. What can be learned from the past efforts and what is different this time around to make this a commercial success

**16:30 Improvements to Disordered Rock-Salt Li-Excess Cathode Materials***Dee Strand, PhD, CSO, 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 conduct.

**16:55 Q&A****17:10 Grand Opening Welcome Reception with Poster Viewing***(Sponsorship Opportunity Available)***18:15 Dinner Tutorial Check-In\*****18:30 Dinner Tutorials 4-7****20:30 Close of Day****TUESDAY, 14 JANUARY****7:30 Symposium Registration & Morning Coffee****SOLID-STATE BATTERIES****8:30 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***8:35 Talk Title to Be Announced***Juergen Janek, PhD, Professor, Justus-Liebig, Universitat Giessen & Festbatt***9:15 A Breath of Fresh Air in Solid State Battery A Game-Changer in Polymer Electrolyte***Mike Zimmerman, Founder, Ionic Materials**John Muldoon, PhD, Senior Principal Scientist, Battery and Fuel Cell Program, Toyota*

Polymer materials are ubiquitous in current battery technology and are commonly used as binders, separators and packaging. Poly(ethylene oxide) (PEO) was first discovered to dissolve Li salts in 1973, making its use as an electrolyte possible. Today, it is still one of the most intensely studied and widely used polymer electrolytes; however, the conductivity is several orders of magnitude lower than inorganic solid electrolytes. This easy-to-synthesize, polymer electrolyte has the potential to be a superior candidate to present-day inorganic solid electrolytes. We will report the properties of a breakthrough polymer technology with a new Li<sup>+</sup> conduction mechanism that does not rely on chain-segmental motion as with PEO. This new polymer electrolyte supports high-Li<sup>+</sup>-conductivity while maintaining a wide electrochemical window. We will present the performance of this electrolyte with a wide variety of anodes and cathodes. Toyota and IM are working in a partnership to advance this technology towards commercialization.

**9:35 Solid-State Batteries – Converging Capabilities and Requirements for Electric Vehicles***Brian Sisk, Vice President, Product Development, A123***9:55 Scaling All Solid-State Batteries: Results from Automated, Roll-to-Roll Pilot Manufacturing***Josh Buettner-Garrett, CTO, Solid Power, Inc.*

Solid Power, an all solid-state battery developer based in the U.S., will share updates from its first quarter of fully automated, roll-to-roll production of

solid-state cells. Solid Power completed its world-class pilot line in the latter half of 2019, which is pushing the company towards automotive qualification with large format cells.

**10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)****SOLID-STATE BATTERIES (CONT.)****11:00 Chairperson's Remarks***Martin Winter, PhD, Chair, Applied Material Science for Energy Conversion and Storage, MEET Battery, Research Center, Institute of Physical Chemistry, University of Muenster***11:05 Solid Polymer Electrolytes Revisited: Practical Considerations and New Concepts***Martin Winter, PhD, Chair, Applied Material Science for Energy Conversion and Storage, MEET Battery, Research Center, Institute of Physical Chemistry, University of Muenster*

For reasons of higher energy density and better safety, research on Li based batteries has discovered solid electrolytes as alternative to liquid electrolytes-again. Compared to ceramics and glasses, solid polymer electrolytes (SPEs) may have the advantage of "wettability", similar to regular electrode binders, in particular with composite electrodes, which is beneficial for both, easy fabrication and long term operation. In this presentation we will cover simple practical aspects of SPE based battery cells as well as new material designs paving the way to high voltage, room temperature solid state batteries.

**11:45 Platform Polymer Matrix Electrolyte (PME®) Technology for Solid-State Lithium-Ion Batteries***Anaba Anani, PhD, Chief Battery Scientist, BrightVolt*

This presentation will share a technical overview of a proprietary polymer matrix electrolyte (PME®) technology developed by BrightVolt for solid-state lithium-ion batteries. It will cover some key performance metrics (test data) collected from conducting common tests widely used by the industry to assess performance of polymer electrolytes.

**12:05 Introduction to Neocarbonix: Binderless Electrodes for Lithium-Ion Batteries***Nicolo Brambilla, Chief Technology Officer, Nanoramic Laboratories*

Electrodes are limited in their electrochemical stability and electrical performance by polymer binders. Nanoramic has developed an alternate solution – Neocarbonix – an electrode platform technology that effectively replaces polymer binders and primers. Results have been demonstrated for both LIB cathodes and EDLC electrodes. Nanoramic's Neocarbonix electrodes have significantly lower ESR, better C-rate capabilities, longer lifetime at high temperature, and greater active material thickness for improved energy density, while also retaining or improving specific capacity.

**12:25 Q&A****12:40 Networking Lunch****13:55 Dessert Break with Exhibit & Poster Viewing****BEYOND LITHIUM-ION****14:40 Chairperson's Remarks***Martin Winter, PhD, Chair, Applied Material Science for Energy Conversion and Storage, MEET Battery, Research Center, Institute of Physical Chemistry, University of Muenster***14:45 Progress on Lithium-Sulfur-Batteries Based on New Electrolyte Formulations***Holger Althues, PhD, Head of Department Chemical Surface and Battery Technology, Fraunhofer IW*

The Lithium-Sulfur-Technology enables cells with high specific energies exceeding Lithium-ion-batteries by more than 50 %. New formulations with reduced polysulfide solubility have been demonstrated to enable the efficient sulfur conversion even at very low electrolyte content. Combined with tailored processing of anodes and cathodes a holistic cell concept is introduced and demonstrated on pouch cell level.



**15:05 Towards Sustainable Na-Ion Batteries**

*Stefano Passerini, PhD, Professor, Helmholtz Institute Ulm, Karlsruhe Institute of Technology*

Renewable materials, environmentally friendly processes, and safer batteries are needed for the sustainable development of electrochemical energy storage. The sustainable use of natural resources is indispensable for future energy storage. As a step towards the utilisation of biowaste, hard carbon produced from waste apples is demonstrated to be a high-performance active material for Na-ion batteries.

**15:25 New Electrolytes for Multivalent Batteries**

*Maximillian Flichtner, PhD, Professor, Helmholtz Institute Ulm (HIU)*

The development of Ca batteries is currently impeded by the lack of electrolytes which can efficiently strip and plate Ca in non-aqueous solvents. [1] Here, we present the feasibility of formulation of Ca and Mg salts with weakly-coordinating anions establishing the access to a new class of efficient multivalent electrolytes.

**15:45 Materials for High Power Devices: Present and Future Trends**

*Andrea Balducci, PhD, Professor, Institute for Technical Chemistry and Environmental Chemistry, Center for Energy and Environmental Chemistry Jena (CEEC Jena, Friedrich-Schiller-University Jena)*

High-power devices, such as electrochemical capacitors and high-power lithium-ion batteries, are nowadays utilized in an increasing number of applications. In this presentation, the advantages and limits of the materials presently utilized in these devices will be analyzed in details. Furthermore, innovative strategies for the identification and introduction of novel materials suitable for the next generation of high-power devices will be presented.

**16:05 Q&A****16:25 Networking Reception with Exhibit & Poster Viewing**

*(Sponsorship Opportunity Available)*

**17:25 Dinner Tutorial Check-In\*****18:00 Dinner Tutorials 8-11****20:00 Close of Day**



# BATTERY ENGINEERING

Building Better Batteries

MONDAY, 13 JANUARY

**8:00 Symposium Registration & Morning Coffee**

## SAFETY AND UNDERSTANDING THERMAL RUNAWAY

**9:30 Chairperson's Opening Remarks**

*Yatish Patel, PhD, Faculty of Engineering, Department of Mechanical Engineering, Imperial College London*

**9:35 Safety Implications of Emissions from Li-Ion Batteries**

*Natalia Lebedeva, PhD, Scientific Project Officer, Joint Research Center of the European Commission*

Emissions of gases, liquids, and solids from Li-ion batteries under various conditions, including battery fire, are outlined. Potential implications on safety of electric vehicles and road infrastructure are discussed.

**9:55 Thermal Runaway Initiation and Propagation in Li-Ion Batteries**

*Andreas Pfrang, PhD, Scientific Officer, Joint Research Centre, Directorate for Energy, Transport and Climate, European Commission*

Finding a thermal runaway initiation method for propagation testing that is representative for a specific failure scenario can be challenging. In this presentation, initiation methods are compared, also based on experiments, and different options for thermal propagation testing are discussed.

**10:15 Initialization of Thermal Runaway in Lithium-Ion Batteries and Measures to Prevent Thermal Propagation**

*Olaf Böse, PhD, Deputy Head of Department, Battery Test Center, ZSW*

Different methods are proposed for the initialization of the thermal runaway (TR) in a Li-ion cell, such as nail penetration, heat injection, overcharge, and short circuit. The TR might spread by thermal propagation (TP) to neighbouring cells in Li-ion-battery-modules and -packs and might evoke hazardous situations if the TP is not confined.

**10:35 Networking Coffee Break**

**11:05 How Calorimeters and Heat Flux Sensors Improve Thermal Management and Safety of Cells**

*Carlos Ziebert, Head of the Calorimeter Center, Thermophysics and Thermodynamics Group, Karlsruhe Institute of Technology (KIT)*

To adapt a thermal management system to the individual needs of the cells, quantitative data of the thermal and safety parameters are needed. It will be shown how these data can be obtained by both calorimetry and heat flux sensors. This allows finding new and quantitative correlations between different, critical thermal and safety related parameters.

**11:25 Cell Temperature Estimation for a Complete Battery Pack Using Limited Thermal Measurement**

*Subhajeet Rath, Research Scientist, Powertrains, TNO Helmond*

In this proposal, a real-time capable "Thermal State Observer" is developed, which can estimate the cell temperature of the complete battery pack from thermal measurements at selected locations. A battery pack model is also developed, which is scalable and modular, and can be applied to a wide range of battery configuration. The algorithms are validated on a cylindrical cell battery module developed in-house.

**11:45 Understanding and Formulations of Material Selection for Battery Pack Designs**

*Terence Kearns, Manager, Business Development, WEVO-CHEMIE GmbH*

WEVO-CHEMIE GmbH, years of research and amassed data from customers, applications, and industry stakeholders, have compiled a simpler guide for material selection. Explain the key attributes and boundaries of each chemistry. Considerations for processing and the consequent disparate influences. Formulated into an easy-to-understand engineering format.

**12:05 Q&A**

**12:30 Networking Lunch**

## BATTERY MANAGEMENT SYSTEMS

**13:55 Chairperson's Remarks**

*Jake Kay, Senior Research & Development Engineer, Research and Development, Thermal Hazard Technology LLC*

**14:00 Sensorless Temperature Measurement Exploiting Online Electrochemical Impedance Spectroscopy**

*Alexander Gitis, PhD Post-Doc/CEO, Aachen University/Safion GmbH*

A novel methodology, which is based on online electrochemical impedance spectroscopy (oEIS) is introduced. The experimental validation with commercial automotive lithium-ion cell shows that a high measurement of accuracy in the range of conventional temperature sensors was achieved even during demanding operation conditions.

**14:20 'True' Isothermal Cell Cycling Data and Its Application to Cell Development and Thermal Management System Design**

*Jake Kay, Senior Research & Development Engineer, Research and Development, Thermal Hazard Technology LLC*

We describe 'true' isothermal data derived using a surface contact temperature control method, developed by THT in collaboration with Imperial College London and Cranfield University. We show how this data is critical for cell development and the design of thermal management systems, and propose testing protocols for adoption by the industry.

**14:40 Proposed Standards and Methods for Leak Testing Lithium-Ion Batteries**

*Sandra Seitz, Dipl.-Ing., Market Manager, Automotive Leak Detection, Marketing, INFICON GmbH*

Detection of micro-leaks in lithium-ion battery cells is absolutely essential to achieve necessary lifetime and safety requirements. This presentation will discuss how small leaks – down to the 10<sup>-6</sup> mbar l/s range – can be detected reliably on potentially leaking battery cells through detection of escaping liquid electrolyte vapors.

**15:00 Q&A**

**15:15 Refreshment Break**

## PREVENTING THERMAL RUNAWAY AND BATTERY FAILURE

**15:50 Chairperson's Remarks**

*Yatish Patel, PhD, Faculty of Engineering, Department of Mechanical Engineering, Imperial College London*

**15:55 Thermal Switching Sheet to Suppress Propagation Behavior of Battery Module/Pack with High Energy Density Cells**

*Tomohiro Kawai, PhD, Senior Chief Scientist, Science & Innovation Center, Mitsubishi Chemical Corp.*

The prevention of thermal runaway propagation between LIB cells inside the battery module/pack has become one of the important challenges for enhancing safety. Mitsubishi Chemical has developed a new concept of thermal sheet with switching function of heat flow between cells. We will introduce the potential contribution to the heat management design of the battery module/pack using the sheet based on thermal simulation.

**16:15 Preventing Lithium-Ion Battery Failure during High Temperatures by Externally Applied Compression**

*Yatish Patel, PhD, Faculty of Engineering, Department of Mechanical Engineering, Imperial College London*

Lithium-ion cells can unintentionally be exposed to temperatures outside manufacturers' recommended limits without triggering a full thermal runaway event. The question addressed in this paper is: Are these cells still safe to use? In this study, externally applied compression has been employed to prevent lithium-ion battery failure during such events.

**16:35 Metal Plastic Hybrid (MPH) Rocker Panel for EV Battery Protection**

*Somasekhar Bobba, PhD, Senior Scientist, Emerging Applications & Prototyping, SABIC*

Honeycomb-based MPH rocker panel structures were designed to absorb impact energy in the available/limited package space for pole impact requirements. Material models (MAT 24 & MAT 187) were developed using high strain-rate data, and simulations were performed to optimize the design using LS Dyna. The MPH rocker panel developed is 40% lighter in weight with similar performance, when compared with the metal solution.

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16:55 Q&amp;A

17:10 Grand Opening Welcome Reception with Poster Viewing  
(Sponsorship Opportunity Available)

18:15 Dinner Tutorial Check-In\*

18:30 Dinner Tutorials 4-7

20:30 Close of Day

**TUESDAY, 14 JANUARY**

7:30 Symposium Registration &amp; Morning Coffee

**CHARGING**

8:30 Chairperson's Opening Remarks

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

8:35 Battery Systems &amp; Charging

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

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.

8:55 Fast-Charging in Practice – A Way to Get It Done!

Michael Schönleber, PhD, CTO, Batemo GmbH

By using a validated and physical battery model, one can, for any condition, assess the anode potential and use this knowledge to avoid Lithium-Plating. In our talk, we will use such a model to derive various practically feasible fast-charging strategies of different complexity. As a reality check, we will apply these strategies to real cells and discuss how well they perform with respect to charging time and aging.

9:15 Low Resistance Negative Electrodes for Fast-Charging Lithium-Ion Batteries

Martin Ebner, PhD, CEO, Batttrion AG

We present a novel fabrication technology that reduces the resistance of negative electrodes of lithium-ion batteries (LIBs). Fast-charging of high-energy-density LIBs is limited by increased degradation brought about by lithium plating on the negative electrode. In this talk, we investigate how reduced negative electrode resistance leads to shorter charging time without compromising energy density, safety, and lifetime.

9:35 Materials Solutions for EV Battery Assembly:  
Thermal Management and Fire ProtectionJulien Richeton, PhD, Technical Service & Development Scientist,  
Dow Performance Silicones, Dow

The large adoption of EV will depend on the industry's ability to meet ever-increasing expectations for reliability, processing, cost, performance, and value. Dow, as a leading chemical company, is providing innovative materials for the assembly and thermal management of battery modules and battery packs. This presentation will review Dow solutions that aim to address the industry challenges.

9:55 Q&amp;A

10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship  
Opportunity Available)**DIGITAL TWINS, MACHINE LEARNING & SECURITY**

11:00 Chairperson's Remarks

Jan Singer, PhD, Battery Engineer, TWAICE Technologies

11:05 Digital Twins for Li-Ion Battery Cells

Peter Birke, PhD, Professor, Institute for Photovoltaik, University of Stuttgart

11:25 Predictive Battery Analytics Software Based on Digital Twins

Jan Singer, PhD, Battery Engineer, TWAICE Technologies

This presentation will cover how digital twins can enable precise determination and prediction of battery performance and health, and can help the industry pave the way for the future, significantly reduce operational and capital expenditures, as well as leverage asset values.

11:45 Battery Intelligence: Using Machine Learning to Make the  
BMS Smarter and Improve Battery Life and Performance

Alexandre Collet, CTO, Research &amp; Development, ION Energy

Estimating the SOH of a battery is still a challenge for many BMS under different applications. The answer lies in Battery Data, which is a useful

resource of meaningful insights to improve its efficiency and extend its life. It provides immense potential to understand battery behaviour under different operating conditions and applications. The huge amount of battery data generated worldwide presents a need for Battery Intelligence Platforms powered by Machine Learning Algorithms to make the BMS smarter and help battery makers improve their battery design and technology.

12:05 Robust SMD Fuses in Higher Safe Power  
Density for Automotive ApplicationLiwu Wang, PhD, Director of Business Development, Business  
Development, AEM Components (USA), Inc.

The solid, robust structure of high-current SMD fuses that are built on patented technologies diversify well the package size and safe power density. All models with current ratings from 20A to 125A are offered the same 2822 package size, which is very suitable for the 48V battery system.

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12:25 Q&amp;A

12:40 Networking Lunch

13:55 Dessert Break with Exhibit &amp; Poster Viewing

**BATTERY INTELLIGENCE**

14:40 Chairperson's Remarks

Tal Sholklipper, CEO, Voltaiq

14:45 Introduction to Battery Intelligence Systems  
(BIS): The Missing Layer in Your Battery Stack

Tal Sholklipper, CEO, Voltaiq

While the industry is familiar with the battery and its battery management system (BMS), very few are aware of the critical need for a missing third layer, the Battery Intelligence System (BIS). The BIS is needed to unlock the significant advances in battery yield, energy density, and lifetime that the industry is calling for. Historically, product OEMs have treated batteries like black boxes, building mechanical and electrical interfaces to keep them stable. As batteries now become the make-or-break component in low-cost EVs and long-lived consumer electronics, companies need the BIS to provide a new level of insight, and ensure that batteries are performant, reliable, and safe.

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15:05 Customizing Lithium-Ion Cells – From the First Material Tests  
to Series Production

Leopold König, CEO, Customcells

Batteries are not a one-fit-all solution. Customcells develops tailor-made and optimized battery configurations that can meet very specific requirements, such as high energy density and C-rates, as well as installation space or temperature requirements. In order to offer the highest quality and thus a long cycle life and safety, we strive for high transparency and corresponding traceability during the development and production process.

15:25 Centralizing Global Battery Analytics and Data Management

Oliver Gross, Energy Storage Systems, Advanced Electrification and Technology, FCA  
USA LLC

This presentation will discuss how FCA is using the power of big data analytics to accelerate battery system qualification while maintaining battery safety, performance, and reliability.

15:45 Scouting New Battery Technologies at Global Scale

Andreas Hinntenach, PhD, Head, Battery Research, Daimler

To meet future battery cell requirements, OEMs must actively track new innovations across the global battery ecosystem. Staying current requires far more than just following the latest press release; OEMs must validate each potential supplier's performance claims through independent testing and qualification. In this talk, Daimler will review our global scouting efforts and the centralized analytics platform we use to track and evaluate new battery technologies.

16:05 Q&amp;A

16:25 Networking Reception with Exhibit & Poster Viewing  
(Sponsorship Opportunity Available)

17:25 Dinner Tutorial Check-In\*

18:00 Dinner Tutorials 8-11

20:00 Close of Day



# CHEMISTRY & MATERIALS FOR LEAD-BASED BATTERIES

## Lead-Based Batteries for Next Generation Commercial Applications

**MONDAY, 13 JANUARY**

**8:00 Symposium Registration & Morning Coffee**

### MODIFIED ADDITIVES, MATERIALS & MODELLING

**9:30 Chairperson's Opening Remarks**

*Neil Hawkes, Commodity Analyst, Lead, CRU*

**9:35 Battery Micro-Cycling in Start/Stop Operation: Oxygen Intermediate Storage Acting as a Charge Buffer**

*Eberhard Meisner, PhD, Formerly Senior Technical Leader, Electrochemistry, Clarios*

When a battery is operated in dynamic duty, e.g. Start/Stop Operation, parasitical gas evolution at positive and negative electrodes do not occur simultaneously. Intermediate storage of oxygen in the cell is of great help to reduce parasitical water decomposition, as oxygen is reduced at the negative electrode at any time of operation. This effect applies to both valve-regulated and flooded battery designs and is extending period of battery usability.

**9:55 Depth Profiling Lead Battery Electrodes during Formation and Cycling**

*Tim Fister, PhD, Materials Scientist, Chemical Sciences and Engineering Division, Argonne National Laboratory*

Maintaining a uniform state of charge (SOC) through a cell is necessary to maximize active material utilization and prolong the lifetime of a lead acid battery. Chemical gradients, however, can arise under high current densities due to variation in acid concentration and non-uniform current distribution. We will present results taken during formation and cycling with variable acid concentration. These results complement prior tear-down studies, while providing new insights that could aid continuum modeling connecting the health of the battery with its average electrochemical response.

**10:15 Limiting Acid Stratification in EFBs during Start/Stop Operation – Can the Battery Separator Play a Role?**

*George Brillmyer, PhD, Manager, R&D, Microporous, LLC*

Through a number of improvements over standard flooded batteries such as compression and modified expander packages, the EFB is designed to better handle partial state of charge operation. Nonetheless, relative to its more expensive cousin, AGM, it still has its limitations. One of these limitations is what is termed "acid stratification", the problematic formation of layers of differing acid concentration in the cell as a result of constant undercharging. This presentation will describe efforts to utilize the battery separator to mitigate this phenomenon through the novel use of scrim and rib designs.

**10:35 Networking Coffee Break**

**11:05 Pb-Acid Separators: The Impact of Raw Material Selection on Structure-Property Relationships**

*Richard W. Pekala, PhD, CTO, Entek*

In this paper, we examine the impact of silica properties (oil absorption, surface area, friability), and SiO<sub>2</sub>/PE ratio on electrical, mechanical, and oxidative properties of the resultant separators. We also investigate techniques to evaluate separator homogeneity at both the macroscopic and microscopic scale. Finally, we address the implications of our findings for SLI and EFB batteries.

**11:25 The UltraBattery for Low Voltage Hybrids by New Positive Plate**

*Atsushi Sato, Research Engineer, R&D, The Furukawa Battery Co., Ltd. Japan*

The 12-V flooded type UltraBattery, a combined lead-acid and supercapacitor hybrid energy storage device, has excellent high-rate partial state of charge durability, excellent dynamic charge acceptability, and lower water loss. In this presentation, new positive plate for the 12-V flooded type UltraBattery and measures for improving the positive grid durability will be discussed.

**11:45 Sponsored Presentation (Opportunity Available)**

**12:05 Q&A**

**12:30 Networking Lunch**

### MARKET & APPLICATIONS

**13:55 Chairperson's Remarks**

*Richard W. Pekala, PhD, CTO, Entek*

**14:00 Present Status and Future Development Trends of the Lead-Acid Batteries – Market, Applications & Chinese Situation in 2019**

*Mark Lu, Industrial Economics and Knowledge Center and Industrial Technology Research Institute, Taiwan*

World lead-acid battery market was 46.92 billion USD, less than 1% growth rate in 2018. Although LABs are still among the biggest sellers in the rechargeable battery market, the future threat exists from the application demand change and replacement from other battery technology like LIB. Therefore, it is necessary to continue monitoring LABs' relevance in the market and the future development on related technologies. 2019 market of lead-acid batteries worldwide: shipment, scope and future growth analysis. The current market and applications' status in Chinese LABs industry in 2019 will be presented.

**14:20 Global Lead Market Challenges and Opportunities in the 2020s**

*Neil Hawkes, Commodity Analyst, Lead, CRU*

The fortunes of the lead battery sector, under threat from the rise of lithium batteries, will be the key factor that determines the lead price path in this new decade. Can lead batteries respond to the threat and defend or even grow its share in some energy storage applications? In addition to the demand path ahead, the response of production, both in mining and recycling, will be crucial in determining whether lead prices are looking up or down as we move into a new decade of both challenges and opportunities for lead.

**14:40 Sponsored Presentation (Opportunity Available)**

**15:00 Q&A**

**15:15 Refreshment Break**

### MARKET & APPLICATIONS (CONT.)

**15:50 Chairperson's Remarks**

*Christian Rosenkranz, PhD, Vice President Engineering & Product Development EMEA, Clarios*

**15:55 PANEL DISCUSSION: Automotive Lead-Acid: Advanced Research & Material Development to Meet Future Automotive Requirements**

*Moderator: Christian Rosenkranz, PhD, Vice President Engineering & Product Development EMEA, Clarios*

*Panelists: Mikaël Cugnet, PhD, Battery Expert, CEA (French Atomic Energy Commission)*

*Tim Fister, PhD, Materials Scientist, Chemical Sciences and Engineering Division, Argonne National Laboratory*

*Ola Hekselman, PhD, Faculty of Engineering, Department of Materials, Imperial College, London*

The proliferation of electric vehicles and the electrification of the power train changes the role of 12V Pb acid batteries. This panel will examine how advanced research methods as well as material development can help to further improve the critical characteristics of the next generation 12V batteries.

**17:10 Grand Opening Welcome Reception with Poster Viewing**

*(Sponsorship Opportunity Available)*

**18:15 Dinner Tutorial Check-In\***

**18:30 Dinner Tutorials 4-7**

**20:30 Close of Day**

**TUESDAY, 14 JANUARY**

**7:30 Symposium Registration & Morning Coffee**

### ADVANCED LEAD-BASED BATTERIES R&D ROADMAP

**8:30 Chairperson's Opening Remarks**

*George Brillmyer, PhD, Manager, R&D, Microporous, LLC*



### 8:35 CBI Technical Overview: Innovation Roadmap and 2019 Technical Program

Matthew Raiford, PhD, Manager, Consortium for Battery Innovation

The newly formed Consortium of Battery Innovation (CBI) has developed an expansive technical program and innovation roadmap for lead acid battery technology. CBI (formerly the Advanced Lead Acid Battery Consortium) focuses primarily on research and innovation for lead acid batteries, but also works on marketing, communications, and new tests and standards for the technology. A technical program of research projects will be presented to demonstrate opportunities for new understanding and enhancements of lead battery technology. CBI aims to lift lead battery technology performance to a higher level, driving sustainable energy storage improvement.

### 8:55 ArcActive EFB Technology

Bernd Engwicht, Director Automotive Battery Application Engineering, East Penn Manufacturing Co.

Micro hybrid vehicles deliver a modest decrease in CO<sub>2</sub> emissions but offer large potential for market penetration due to low cost. In order to increase the impact these vehicles have in reducing global emissions, the benefits of increased battery usage should be consistent throughout the life of the vehicle. To achieve that goal, the battery must dependably handle large regen currents. Using techniques to test the battery when new and when aged, we will demonstrate the advantage of this technology in terms of CO<sub>2</sub> emissions. A novel grid and pasting technology, teamed with the optimal battery design, make this performance viable.

### 9:15 A High-Power VRLA Battery for 48V Systems

Michael Gilchrist, Co-Founder, HighWater Innovations, LLC

This presentation will discuss a high-power low aspect ratio VRLA battery option for this application. With specific power 3 times that of conventional VRLA (1,050 W/kg 10 sec pulse power), this innovative battery design not only has the inherent recyclability/safety of Pb with multiple fitment options, but also offers the OEM a viable lower cost option for their advanced vehicles.

## TECHNOLOGY & INNOVATION: DCA VS. HIGH TEMPERATURE DURABILITY

### 9:35 Dependencies of the Dynamic Charge Acceptance

Juergen Garche, PhD, CEO, FCBAT

Stop/start operations of cars is a relatively cheap way to reduce the fuel consumption and so also the CO<sub>2</sub> emissions – about 10-40 €/ % CO<sub>2</sub>. A prerequisite for that, however, is as complete as possible absorption of the break energy (which is dynamic and not constant) by the LAB. The dynamic charge acceptance mainly determined by the negative electrode is influenced by cell design and materials but also by operating parameters, e.g. T, SOC, charge/discharge history, and rest time.

### 9:55 Q&A

### 10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

### 11:00 Chairperson's Remarks

George Brilmyer, PhD, Manager, R&D, Microporous, LLC

### 11:05 An Update on ArcActive Battery Performance

Stuart McKenzie, CEO and Managing Director, ArcActive

Having a battery that achieves high Dynamic Charge Acceptance and while at the same time low Water Consumption is the key technical challenge facing the lead battery industry. This presentation will provide a brief overview on ArcActive's DCA and Water Consumption performance, as well as new test results exploring other performance criteria, as the ArcActive technology progresses towards market entry.

### 11:25 Understanding the Charge Acceptance of Thin-Plate Positive Electrode Using a Titanium Microgrid® Current Collector

Mikaël Cugnet, PhD, Battery Expert, CEA (French Atomic Energy Commission)

A physics-based model is developed to study the impact of the positive electrode design on its charge acceptance. The design of experiments includes two titanium MicroGrids® from DEXMET with different thicknesses, and one pure titanium foil that is thicker, combined with different thicknesses of lead-dioxide active material.

### 11:45 Correlation of Dynamic Charge Acceptance and Impedance Spectroscopy

Sophia Bauknecht, Department of Electrical Energy Storage Technology, Technische Universität Berlin

This talk will outline the correlation between DCA and impedance spectroscopy of lead battery cells with and without additive enhanced negative plates. Thus, several cells are tested and compared concerning their DCA and impedance spectra with reference electrodes before and after run-in. The test results are used to locate and identify the processes affecting the DCA within the spectra, this can be used for generating an equivalent circuit model of the negative half cell as a prediction tool for DCA.

### 12:05 Sponsored Presentation (Opportunity Available)

### 12:25 Q&A

### 12:40 Networking Lunch

### 13:55 Dessert Break with Exhibit & Poster Viewing

## INNOVATION IN LEAD ACID

### 14:40 Chairperson's Remarks

Matthew Raiford, PhD, Manager, Consortium for Battery Innovation

### 14:45 PANEL DISCUSSION: How Innovation Can Support Advanced Lead Batteries in New BESS and Industrial Applications

Moderator: Matthew Raiford, PhD, Manager, Consortium for Battery Innovation

Panelists: Frank Fleming, Manager, Electric Applications Incorporated

Herbert Geiss, PhD, Consulting Director, Pyramid Vision Consulting

Allen Stoneberg, Director, Product Engineering, Trojan Battery

The growing ESS and industrial battery market is facilitated by the societal need for greater electrification and hybridization of the energy grid. Lead batteries are a key technology in this sector and offer many advantages based on sustainability and cost. This panel will discuss the areas of research and challenges for lead batteries in this market and what are important characteristics to improve for lead batteries in these markets.

### 15:25 Challenges in the Development for Long-Life High-Power Lead Acid Batteries

Bernhard Riegel, PhD, Director of Research, Hoppecke Batterien GmbH & Co. KG

The standard layouts of lead acid batteries involve traditionally the compromising of high power with cycle life performance at high DoDs. In our presentation we discuss the main requirements to achieve high power capability, large numbers of capacity turnovers (CTO) and the effect of the conflictive material properties involved. In the last years, a great progress for industrial battery applications (material handling, UPS and utilities) was achieved to overcome these limitations. This was made possible by the introduction of new manufacturing technologies, processing and the implementation of novel materials (alloys, additives, separators).

### 15:45 The Effect of Carbon Additives on the Short-Term and Long-Term Dynamic Charge Acceptance

Jochen Settelein, PhD, Expert Group Manager Lead-Acid Technology, Fraunhofer R&D Center Electromobility, Fraunhofer Institute for Silicate Research ISC

In this presentation, a comparison between the static charge acceptance, the dynamic charge acceptance after EN standard and the long-term DCA after battery run-in is given. Results from flooded 2 V laboratory test cells are presented which include a series of different carbon additives in the negative electrodes. A link between electrochemical properties of the negative active material and the dynamic charge acceptance is provided.

### 16:05 Q&A

### 16:25 Networking Reception with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

### 17:25 Dinner Tutorial Check-In\*

### 18:00 Dinner Tutorials 8-11

### 20:00 Close of Day



# BATTERY RECYCLING

## Advanced Recycling Methods for Sustainable Battery Materials Supply

MONDAY, 13 JANUARY

8:00 Symposium Registration & Morning Coffee

### RECYCLING MARKET DEMAND

9:30 Chairperson's Opening Remarks

Ahmad Pesaran, Chief Energy Storage Engineer, National Renewable Energy Laboratory

9:35 Challenges and Options for the Recycling of Present and Future Batteries

Marcel Weil, PhD, Director, Engineering, Karlsruhe Institute of Technology (KIT) Institute for Technology Assessment and Systems Analysis

Due to the finite nature of mineral resources and the sometimes high environmental impact of raw material extraction, recycling is seen as central to a positive environmental balance of battery storage application. Irrespective of this, some post-lithium storage systems are currently being developed, but very little is known about their recyclability in principle. This presentation will cover the technology development oriented towards the use of cost-effective materials that can lead to low economic incentives for recycling.

9:55 Recycling vs. Second Life: Not One Size Fits All

Tim Grejtak, Analyst, Lux Research

The value of battery recycling is dependent on cell chemistry and recycling process, much like how second life is dependent on application and use case. Often, both are treated as binary choices in monolithic markets, but the reality is more nuanced. Lux will review where and when Li-ion battery recycling and second life use make sense, and identify what market opportunities are available for automakers, chemical companies, and utilities.

10:15 Closing the Battery Loop

Maarten Quix, Manager, Recycling Development, Umicore

The purpose of this presentation is to give an estimation of the expected metals need, but also the available feed for recycling in the years to come. Umicore is a leading company in the field of active materials for LIB as well as the recycling of LIBs and their associated production scrap. Today's cathode materials are using a complex mix of specific metals (lithium, nickel, manganese and cobalt) as raw materials, depending on the addressed application. A short example of Umicore's approach will be given to round up the presentation.

10:35 Networking Coffee Break

### EUROPEAN REGULATORY LANDSCAPE, TRANSPORTATION & SAFETY

11:05 Can the EU Regulation Support the Battery Industry Development in Europe?

Claude Chanson, PhD, General Manager, RECHARGE - The Advanced Rechargeable & Lithium Batteries Association

The EU Commission is currently revising the Batteries Directive 2006/66 in the framework of the strategic development of the industry associated to e-mobility. Can we expect practical regulatory requirements, enabling the control of a sustainable and circular economy, while at the same time boosting the European battery industry competitiveness? RECHARGE is closely cooperating with the EU Commission to define the key aspects of the future European regulation (updated Batteries Directive, Ecodesign Directive, and others). Opportunities and threats of the ongoing proposals, including RECHARGE positions, will be presented and discussed.

11:25 Multimodal Transport Rules for Lithium Batteries and Equipment Containing Lithium Batteries

Marco Ottaviani, Battery Regulatory, Environmental and Safety Affairs - Dangerous Goods Safety Adviser, Italy

Compliance with transport rules of lithium batteries requires the preliminary identification of several parameters of the batteries to be transported because rules vary if they are new, waste, damaged and defectives or prototypes. Furthermore road, sea and air transport mode apply with different timing. An overview of multimodal transport regulations (ADR, IMDG, IATA) will be illustrated in the presentation along with the new rules and provision of packagings, marks, labelling and documents required for the shipment of

lithium batteries and appliances containing such batteries.

11:45 Product Entropy and LCA as Tools to Estimate Environmental Impacts of Battery Recycling

Nicolas von Drachenfels, Technical University of Braunschweig

It is important to know the potential environmental impacts of different battery technologies in order to identify hotspots of environmental impacts throughout the life cycle. Life Cycle Assessment (LCA) is the most commonly used method for calculating the environmental impacts of product systems, as it takes into account all life cycle stages and is able to identify trade-offs and problem shifts. However, it has high data quality and quantity requirements. Fulfilling these requirements is challenging as data is usually scarce, especially with regard to information on recycling of relatively new battery chemistries. Therefore, other methodologies need to be developed to assist the assessment of environmental impacts for battery recycling. The presented approach shows how the product entropy can be incorporated into LCA in order to estimate the potential environmental impacts of the recycling. This approach can be used in several applications, two of which are presented here.

12:05 Q&A

12:30 Networking Lunch

### OEM PERSPECTIVES ON RECYCLING

13:55 Chairperson's Remarks

Marco Ottaviani, Battery Regulatory, Environmental and Safety Affairs - Dangerous Goods Safety Adviser, Italy

14:00 xEV Batteries at End of Vehicle Life – Opportunities – Regulatory Requirements for OEM – Recycling

Roland Matthé, Technical Fellow Battery Systems & Electrification Architecture, Engineering Propulsion Systems, Opel Automobile GmbH

This presentation will cover current experience with repair, re-use, refurbish and recycling as well as future requirements for re-use and recycling and OEM motivation for improvement of methods and processes.

### COST-EFFECTIVE RECYCLING

14:20 What Could Make EV Lithium-Ion Battery Recycling Economical?

Ahmad Pesaran, Chief Energy Storage Engineer, National Renewable Energy Laboratory

There are many technical, logistic, and economic challenges to the collection, storing, sorting, and transporting end of life EV batteries to recycling facilities. These challenges include lack of infrastructure, transportation cost, difficulty in disassembly and identification, lack of practices and designs for recyclability, and use of less valuable materials for recycling. In this presentation we will discuss what opportunities exist in the whole life cycle of lithium-ion batteries to potentially make Li-ion recycling economical.

14:40 Sponsored Presentation (Opportunity Available)

15:00 Q&A

15:15 Refreshment Break

### COST-EFFECTIVE RECYCLING (CONT.)

15:50 Chairperson's Remarks

Marco Ottaviani, Battery Regulatory, Environmental and Safety Affairs - Dangerous Goods Safety Adviser, Italy

15:55 Opportunities to Improve Razor-Thin EV Margins through Safe & Efficient Recycling

Steven E. Sloop, President, OnTo Technology LLC

This presentation will outline OnTo's three-part strategy for safe and efficient lithium-ion recycling: (1) Elimination of hazards to make batteries safe for transport, which addresses half of the end-of-life liability (2) Reclamation of candidate materials with cathode-healing™ for less than \$5/kg, and refining of (3) New manufacturing, clean-precursors. For such a developed industry, the realities of a wholistic approach for sustainable (economic and otherwise) lithium-ion battery manufacturing are largely untapped. These approaches offer unique, scalable, patented methods to address it.



### 16:15 Overcoming Cost Barriers by Setting Up Affordable and Profitable Technology of Lithium-Ion Battery Recycling for Black Mass Exportation

Jayden Goh, CEO, Global Logistics Center, Anhua Taisen Recycling Technology Co. Ltd., China

The complete treatment of Li-ion batteries is expensive and not every country has enough investment in battery recycling to treat its own waste without the need for exportation to overseas. Within a wide analysis of the industry and its aspects, the study reveals the solution for the treatment of lithium-ion battery worldwide by the set-up of affordable and profitable equipment to treat waste batteries and export black mass.

### 16:35 Eco-Friendly Recycling of Lithium-Ion Batteries

Christian Hanisch, PhD, CEO, Duesenfeld

### 16:55 Q&A

### 17:10 Grand Opening Welcome Reception with Poster Viewing

(Sponsorship Opportunity Available)

### 18:15 Dinner Tutorial Check-In\*

### 18:30 Dinner Tutorials 4-7

### 20:30 Close of Day

## TUESDAY, 14 JANUARY

### 7:30 Symposium Registration & Morning Coffee

## RECYCLING METHODS

### 8:30 Chairperson's Opening Remarks

Steven E. Sloop, President, OnTo Technology LLC

### 8:35 Battery Characterization under Rapid Charging for Reuse and Recycling

Shuichi Uchikoga, PhD, Senior Fellow, Battery Division, Toshiba Corporation

There will be a need for a practical characterization method to evaluate batteries for reuse and recycling where large numbers of batteries are considered to emerge from the EV market. The proposed method combines impedance measurement and capacitance analysis under rapid charging which allows us to understand the cause of degradation together with state-of-health. The measurement completes during charging and obtained data is analytic to provide classification for reuse batteries.

### 8:55 Battery Recycling: A Sustainable Approach to Design

Jenny Mash, PhD, Research Scientist, Recycling & Separations Technology, Johnson Matthey

### 9:15 Increasing the Recycling Rate of Spent Lithium-Ion Battery Recycling by Recovering Spheroidized Graphite

Anna Vanderbruggen, Post Doc, Engineering Department, Helmholtz Institute of Freiberg

Recycling of LiB has attracted a lot of attention and is particularly focusing on the valuable metals such as cobalt, nickel and lithium. Despite the growth in graphite consumption and the fact that it is counted as a critical material, there is little previous work focusing on graphite recycling. Thus, graphite usually remains in slags from the metallurgical treatments. The aim of this research is to increase the recycling recovery of the LiBs by developing a new innovative process, which minimizes metal losses and is able to recover graphite.

### 9:35 Creating a Secondary Source for Critical Battery Materials

Kunal Phalpher, Chief Commercial Officer, Li-Cycle Corporation

This presentation will explore the need for 'mega' scale lithium-ion battery resource recovery globally, the challenges of lithium-ion (Li-ion) recycling and how Li-Cycle™ is able to overcome these challenges to recover 80-100% of critical materials from Li-ion batteries. Li-ion batteries play an essential role in the global transition toward electrification. Being one of few companies focused on recycling Li-ion batteries, Li-Cycle has a unique insight to the challenges and opportunities of the industry, as well as the necessity for proper end-of-life logistics management.

### 9:55 Q&A

### 10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

## RECYCLING METHODS (CONT.)

### 11:00 Chairperson's Remarks

Steven E. Sloop, President, OnTo Technology LLC

### 11:05 Strategies for Water Treatment and Conservation in the Next Generation of Metals Recycling

Mohamed Abdou, PhD, Innovation Manager, Dupont

DuPont Water Solutions is the leading global supplier of wastewater treatment technologies, including reverse osmosis, nanofiltration, ultrafiltration, ion exchange resin, and others. Joined collaborations with key partners have resulted in the development of new strategies for wastewater treatment and conservation in the next generation of battery recycling and metal extraction. Preliminary results and the implication of these new strategies on wastewater treatment will be presented.

### 11:25 The Potential of Waterjet Technology for Battery Recycling

Mohamed Hashish, Senior Technology Fellow, Shape Technologies Group

The "Waterjet" as a tool represents a wide range of energetic fluid jet and abrasive-fluid jets capable of cutting materials safely and without heat effects. These tools promise to meet the multiple requirements of cutting batteries safely and economically for the purpose of recycling and transportation. In this presentation, we discuss a few examples such as Abrasive Waterjets (AWJ) which have been proven to be effective for cutting similar materials to those used in batteries in air and submerged under water. The implementation of waterjet tools however, will rely on the overall economic and environmental feasibility which is discussed.

### 11:45 Solution-Based Lead Recycling Using Deep Eutectic Solvents

Ola Hekselman, PhD, Faculty of Engineering, Department of Materials, Imperial College, London

In our work, we develop new low-temperature chemical and electrochemical routes for lead recycling via solution-based processing. We lower overall energy usage and significantly reduce lead-to-air emissions from lead recovery process by using deep eutectic solvents (DES). These solvents are composed of low-cost, easy to handle, environmentally benign chemicals and, most importantly, they have an ability to dissolve a wide range of inorganic compounds – including oxides. The talk will provide an insight into this unique behaviour by analysing speciation of Pb in DES.

### 12:05 Sponsored Presentation (Opportunity Available)

### 12:25 Q&A

### 12:40 Networking Lunch

### 13:55 Dessert Break with Exhibit & Poster Viewing

## RECYCLING METHODS (CONT.)

### 14:40 Chairperson's Remarks

Stefan Elsner, Head, Operations, GRS Batterien Service GmbH

### 14:45 Use of Direct Recycled Active Materials in Li-Ion Batteries

Michael Slater, PhD, R&D Manager, Farasis Energy

Advanced recycling processes for Li-ion batteries can recover and reuse valuable active materials directly. This approach can improve value recovery from both manufacturing scrap and spent batteries over currently used recycling processes. As well as lowering the overall environmental burden associated with the Li-ion battery life cycle, improved recycling processes help meet regulatory requirements for recycling of end-of-life EVs/batteries. Characteristics of direct recycled active materials and the performance of Li-ion cells that utilize such materials will be presented.

### 15:05 Integrating Latin America to the Global Waste Lithium-Ion Battery Closed Loop: A Must for Reduction of Greenhouse Gas Emissions and an Opportunity for Sustainable Development

Guillermo Pereira, CEO, Fortech

There is a need of bringing regional solutions to the global need for recovery of valuable metals that shall be turned back into resources to be used by the manufacturers of new batteries. To make this possible, in our view, it is essential to launch more collection programs encouraging efficient and environmentally sound recycling throughout technological platforms able to include innovative "gamification" and "prize" incentives to the participants in the reverse logistics value chain. The programs must count with the support of the OEM's, the wholesale, retail and repair/refurbish channels to succeed.



## REUSE & SECOND LIFE

### 15:25 Safe Handling and Transportation of Lithium Batteries

*Stefan Elsner, Head, Operations, GRS Batterien Service GmbH*

This presentation will cover the joint collection scheme for portable batteries. In addition we will discuss waste lithium batteries – a growing safety risk, GRS safety standard and multi-country collection of end-of-life EV batteries.

### 15:45 Environmental Benefits of Used Batteries from E-Vehicles as Stationary Energy Storage

*Juergen Koelch, PhD, Associate Lecturer, EVA Fahrzeugtechnik GmbH*

The environmental benefits of an electric vehicle face repeated criticism. Along with the use of CO<sub>2</sub>-intensive, coal-based electricity for vehicle operation, the ecological rucksack of the battery is the primary focus. When the battery is reused at the end of the vehicle's service life, the environmental benefits far exceed those of just regular recycling.

### 16:05 Q&A

### 16:25 Networking Reception with Exhibit & Poster Viewing

*(Sponsorship Opportunity Available)*

### 17:25 Dinner Tutorial Check-In\*

### 18:00 Dinner Tutorials 8-11

### 20:00 Close of Day



# xEV BATTERY TECHNOLOGY, APPLICATION, AND MARKET

**WEDNESDAY, 15 JANUARY****8:00 Conference Registration & Morning Coffee****PLENARY SESSION: xEV MARKET EXPANSION****8:40 Chairperson's Opening Remarks***Menahem Anderman, PhD, President, Total Battery Consulting, Inc.***8:45 The Path to Zero-Emission Road Transport in Norway: Past Incentives and Future Goals***Sigve J. Aasebo, Senior Advisor, Norwegian Public Roads Administration*

Zero emission transport is a cost-effective measure to reduce carbon emissions. Incentives for electrification started out in 1990 and have been both long-term and increasing with time. The goals of 2025 are to stop selling vehicles with ICE in passenger cars, city busses and light-weight vans. By 2030, no heavy vans with ICE, and maximum 25% of long-distance busses and 50% of new HDV with ICE. Will Norway reach the world's most ambitious goals?

**9:05 The Battery Market and Main Trends 2020-2030***Christophe Pillot, Director, Avicenne Energy*

The presentation will analyze the current global battery market and provide some forecast for Lithium-ion batteries and their impact on the supply of raw materials.

**9:25 Cathode Market Expansion: Challenges and Opportunities***Tom van Bellinghen, Marketing & Sales Director, Rechargeable Battery Materials, Umicore*

EV penetration of somewhere between 1 and 2 % has turned cathode landscape upside down. How to prepare for the 100\$/kWh, when price parity with ICE will be reached and the real growth will start? Decreasing cost, increasing energy density, improve product purity, ensuring raw material availability and upstream mining investments, while guaranteeing ethical and environmental standards, all at a lower CO2 footprint: a lot of balls to keep in the air.

**9:45 Sustainability in the Battery Value Chain***Jonas Augustin, Engagement Manager, McKinsey & Company, Inc.*

Batteries are a key enabler to electrify transport and realize the energy transition. The tremendous growth in demand for batteries will, however, impose a number of economic, environmental, and societal challenges to the entire value chain from raw material mining all the way to end-of-life. A sustainable scale-up of the battery value chain is required to ensure the positive impact of batteries. Circular economy and responsible practices will be a core part of the solution.

**10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)****11:00 The Big Question about PHEV vs. BEV – What Does the Actual Trend Suggest?***Viktor Irlé, Market Analyst, EV-Volumes.com*

This presentation will look at PHEVs and BEVs from a global perspective but also focus on Europe in more detail. It will examine what the actual data suggests, who the active OEMs are in the field, which models are the best sellers, how Chinese policy influences what European automakers bring to the market, and how the near-future forecast on BEV vs. PHEV looks.

**11:25 Chinese xEV Market: Vehicle, Battery, and Materials Impact***Mark Lu, PhD, Certified Senior Industrial Analyst, ITR, Taiwan***11:55 Q&A****12:20 Networking Lunch (Sponsorship Opportunity Available)****13:30 Dessert Break with Exhibit & Poster Viewing****xEV BATTERY TECHNOLOGY****14:15 Chairperson's Remarks***Matthias Ullrich, PhD, Head of Battery Cell Development, Center of Excellence – Battery Cell, Volkswagen AG***14:20 Renault EV and Its Battery Evolution***Masato Origuchi, Electrical Energy Storage System Expert, Renault*

Renault, as the leader of European EV market, has been continuously improving the top seller EV Zoe and its battery. The recently launched new model Zoe has also a larger energy battery within the same battery pack size. The presentation

will explain the technical details of Zoe batteries and also will discuss and suggest, based on the cumulated Zoe customer field data, the direction of further battery improvement which should not be limited to just increasing the energy density.

**14:40 The Battery System for Volkswagen's New Electric Platform MEB***Holger Manz, PhD, Head of Development for Vehicle Energy Supply and High Voltage Systems, Volkswagen AG*

In recent years, E-Mobility has reached an unprecedented degree of public focus. Unexpected by many, fully electric automobiles have evolved from experimental status to real life relevance. This technology is now a fact on the road and people enjoy using it. The presentation provides an overview of Volkswagen's efforts in the field of battery systems and their associated technology covering the last 10 years. Looking forward into the future, the paper explains the challenges related to the next generation of battery systems and provides insights into the latest platform of Volkswagen's Battery Electric Vehicle Technology, the MEB.

**15:00 Electrification Strategy of the PSA Group Focused on Battery Systems***Emmanuelle Lancelle-Beltran, PhD, Battery System Expert – Storage Systems & Electrotechnics, PSA Group*

Thanks to the planned extensive electrification of the models, PSA Groupe will soon bring more battery electric vehicles and plug-in hybrids onto the market. Clearly, the battery technology is one of the major keys to realize such ambitious product portfolio and sales targets. Regarding the way to develop Low Emission Vehicle technologies, the strategy is based on 2 pillars : multi-energy platforms and transition from a "buy" strategy to a "make" strategy of key components of electrified powertrain such as the battery. Thus, PSA Groupe is improving its battery skills as battery integrator. In this overview presentation, the PSA Groupe strategy on battery development will be explained."

**15:20 Charging Ahead: Commercializing Fast-Charge Si-Dominant Li-Ion Cells for EVs***Sponsored by*  
*Benjamin Park, PhD, Founder & CTO, Enevate Corporation*

Enevate's pure silicon-dominant Li-ion cells utilize a novel anode. Unique properties include extreme fast charge while increasing high energy density, wide temperature operation, safety, and potential for reduced cost. Technical developments, cell operation and design principles, and commercialization progress for use in EVs will be discussed.

**15:40 Refreshment Break with Exhibit & Poster Viewing****16:30 Glimpses into BEV Batteries on the Market – AVL Series Battery Benchmarking***Wenzel Prochazka, PhD, Senior Product Manager, Global Battery Competence Team, AVL List GmbH*

The comparison of technical and commercial information of batteries in electrified propulsion systems is a key factor to gain state-of-the art knowledge and engineering methodology understanding. But how comparable is the available data in order to gain knowledge about key-functions of the battery-systems and their interactions? AVL's series battery benchmarking 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 are pointed out to support current and future development programs. This talk focusses on the battery systems of current example vehicles, the AUDI E-tron quattro, JLR iPace and Tesla Model 3.

**16:50 Lithium-Ion Battery for Future Electric Vehicles: Challenges and Perspectives***Wonhee Jeong, PhD, Leader, BEV Cell Development Team, LG Chem*

Electric vehicles based on lithium-ion batteries have emerged as environmentally sustainable transport systems. Automotive manufacturers start building their dedicated electric vehicle platform with various electric driving ranges and fast charging capability. In this talk, LG Chem's current lithium-ion battery solutions to this fast-evolving market will be discussed with



a focus on technical challenges and battery design for low cost. Also, we will explore practical aspects of lithium-ion battery technology required for future electric vehicles.

### 17:10 Empowering Mobility

Mark Ellis, Technical Lead Automotive, Battery Systems, Northvolt

An overview of the how the Northvolt Battery Systems business integrates into the Northvolt business with our focus on sustainability, connectivity & modularity. Details of some present applications in the Off-highway vehicles market, the technical challenges that these present and an outline of the future directions, as module & pack production scales with the Northvolt cell production capability.

### 17:30 Q&A

### 18:00 Close of Day

## THURSDAY, 16 JANUARY

### 7:30 Conference Registration

### 8:00 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.

## BATTERIES FOR LOW-VOLTAGE HYBRIDS

### 9:00 Chairperson's Opening Remarks

Eckhard Karden, PhD, Technical Expert for Battery & Energy Storage Technology, Ford Aachen

### 9:05 The Next Generation of 12V Lead-Acid Start/Stop Batteries with Optimized Charge Acceptance and Balanced Real-Life Behavior

Dirk Weber, Vice President Start-Stop Engineering & EMEA, Clarios

CLARIOS is continuously working on an optimization of lead-acid batteries for various applications, primarily focusing on AGM. Based on this experience and the increasing demand for improvements in various product lines, CLARIOS is developing the next generation of EFB batteries with a more balanced footprint regarding charge acceptance and hot climate durability. Main target is the development of a product portfolio with satisfying performance under modern test regimes like e.g. WLTS, key-life-test (KLT) considering potential trade-offs in real life behavior. The presentation will discuss i) dynamic charge acceptance improvements in modern test regimes, ii) the impact on field relevant performance indicators, considering high- and low temperature conditions, and iii) the potential limitations of current test procedures, seen from a developer's standpoint.

### 9:25 Supercapacitors in Low-Voltage Automotive Systems

Stefan Werkstetter, Head of Applications Engineering, Skeleton Technologies

Ultracapacitors are now used for more than 8 years in low voltage automotive systems, with millions of vehicles on the road today equipped with this energy storage technology. Skeleton Technologies is working on future ultracapacitor technology with significantly increased energy density. These next-generation ultracapacitors can address more applications like autonomous driving backup, electric power assisted steering, decentralized power backup and electric catalyst heating. The presentation will give an overview of today's and tomorrow's applications

### 9:45 Low-Voltage Systems with Li-Ion Batteries

Ian Braime, Executive Director of Low Voltage Product Management, A123 Systems

48V MHEV is established as a key technology in the European industry's quest to meet increasingly demanding emissions regulations. This presentation will look at A123's 48V cell and battery road map and how A123 as a market leader in 48V is managing diversity in technical requirements and how A123's new battery solutions are providing increasing value and performance to the MHEV system for customers in Europe and China.

### 10:05 Q&A

### 10:25 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

## xEV BATTERY FUTURE OUTLOOK

### 11:10 Chairperson's Remarks

Arnold Lamm, PhD, Founder and Executive Director, e-Technologies GmbH

### 11:15 Large-Scale Automotive Cell Manufacturing in Europe – Overview

Markus Hackmann, PhD, Head of e-Mobility, P3 Automotive, GmbH

Currently the supply market of lithium-ion battery cells is dominated by South Korean, Chinese and Japanese players as these introduced this technology to the market. Most of the required sub-components and raw materials for these new production locations will initially be sourced from domestic and established supply chains in Asia. This presentation will discuss the chances and risks for localized European players and industry segments to enter these supply chains due to e.g. missing infrastructure and local production facilities of the established competitors as well as open technology fields. Success factors will be identified.

### 11:30 Large-Scale Automotive Cell Manufacturing in Europe – Chances and Risks for New Entrants

Arnold Lamm, PhD, Founder and Executive Director, e-Technologies GmbH

The national platform of electromobility in Germany pictures the complete value chain besides the cell and the cell manufacturing. New national projects in this field are now on the way. The European Commission, powered by Germany and France, is also pushing cell manufacturing consortia.

The questions are: What are the key success factors in order to become competitive with the Asian cell manufactures? What is the utilization concept out of these pilot plants? This presentation will consequently discuss the chances and risks for localized European players and industry segments to enter these supply chains. For example, it will look at missing infrastructure and local production facilities of the established competitors as well as open technology fields, and highlight the success factors identified so far in the industry, and show P3's view on success factors and road blocks for new entrants in the battery cell manufacturing business to participate and compete with the dominant market players. In this context the depth of vertical integration into the value chain of battery cell production will be most of interest as it defines the amount of potential chances and risks.

### 11:45 How to Make Automotive Batteries a Better Business?

Oliver Spreitzer, Partner, Strategy Engineers GmbH & Co. KG

Until 2030, the majority of new passenger cars sold in developed countries will be electrified. To prepare, automotive OEMs as well as suppliers are busy developing batteries and mastering production. On the one hand materials needed for these batteries are not yet mined in the right quantities and on the other hand the usage of batteries for recycling or even secondary use are not clear business cases today. As a result of the tentative ramp-up in production volumes electric vehicles are seeing today, there is only limited demand for traction battery recycling. The question is, when critical quantities of used battery packs will be returned to the OEMs. With the emergence of second use applications like charging infrastructure and decentralised storage solutions, the ramp-up of recycling volumes might be a few years down the road. This opens a window of opportunity to develop the value chain after designed-for usage and establish the required business models along the battery life cycle.

### 12:05 Li-Ion Battery Innovation Roadmap

Tim Grejtak, Analyst, Lux Research, Inc.

Understanding how and when innovations in Li-ion battery anode, cathode, and electrolyte materials will make it to market is key to succeeding in the Li-ion battery and electric vehicle industries. This presentation will forecast the market share of anode and cathode technologies, including solid-state batteries, over the next 20 years to build a Li-ion battery material roadmap. It will also present projections for energy storage demand across all transportation sectors to highlight key market opportunities.

### 12:25 Q&A

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



**xEV BATTERY SUSTAINABILITY AND LOGISTICS**

**13:40 Chairperson's Remarks**

Roland Matthé, Technical Fellow Battery Systems & Electrification Architecture, Engineering Propulsion Systems, Opel Automobile GmbH

**13:45 Electrification at Opel – from BEV and PHEV to Intelligent Charging Infrastructure and Reuse of xEV Batteries**

Roland Matthé, Technical Fellow Battery Systems & Electrification Architecture, Engineering Propulsion Systems, Opel Automobile GmbH

**14:05 CO2-Neutral Battery Production in Europe – How to Make It Happen**

Robert Stanek, Partner, E-Mobility, P3 Automotive GmbH

First, we will start with an overview of the energy required for each step along the lithium-ion battery production value chain and uncover current typical CO2 emissions for a reference site in Europe. Following this we will introduce short, medium and long term potentials to reduce CO2 emissions for a European location. Here, we are focusing on raw material sourcing and processing as well as battery cell manufacturing. Lastly, the presentation will indicate suitable strategic approaches to achieve CO2-neutral yet economically feasible battery production in Europe.

**14:25 Sustainability of EV Batteries: It Starts with Raw Materials**

Guido M. Dona, Director, Planning & Strategy, Arkema

While there is no doubt on the zero emission aspect of full electric cars when used, the virtuosity of their overall carbon footprint is still under debate. The origin of the electricity is of prime importance for sure as well as the carbon footprint of the battery itself. Arkema, as a designer of materials and innovative solutions, is definitively engaged in supporting the development of more sustainable lithium-ion batteries. This presentation will highlight how a Specialty Chemical Company with an eco-design mindset can contribute positively: from green electrification to recyclability, while going through greener electrode manufacturing and bio-based materials.

Sponsored by  
**ARKEMA**

**14:45 Q&A**

**15:00 Refreshment Break**

**CLOSING PLENARY SESSION: BATTERY LIFE AND RELIABILITY**

**15:15 Chairperson's Remarks**

Falko Schappacher, PhD, Member of the Board of Directors, MEET Battery Research Center, University of Muenster

**15:20 Li-Ion Battery Life in xEV Applications**

Falko Schappacher, PhD, Member of the Board of Directors, MEET Battery Research Center, University of Muenster

**15:40 Life-Limiting Mechanisms in Li-Ion Automotive Technology**

Thomas Waldmann, Team Leader Post-Mortem Analysis and Aging Mechanisms, PhD, ZSW

In order to improve battery life time, the underlying aging mechanisms have to be identified. This presentation gives an overview on Post-Mortem analysis and aging mechanisms in different commercial state-of-the-art cells. The results are complemented with lab cells with reference electrode. The investigated mechanisms include Li deposition, SEI growth, and dissolution of silicate species from Si/C composite anodes. We show how the mechanism of Li plating can be hindered for fast-charging in commercial 16Ah pouch cells.

**16:00 Development and Validation of xEV Battery Life Models**

Veronika Obersteiner, PhD, Project Manager IODP, IODP Architecture & Technology, AVL List GmbH

Battery life has been one of the major obstacles to lithium-ion battery popularity in recent years, as it directly limits the electrical range over the lifetime of the xEV. Therefore, efficient methods for characterizing the complex process of battery ageing are needed. Utilizing these models for the development of strategies to analyze the battery degradation can enable a significant extension of the xEV's life. Current modeling approaches, ranging from electro-chemical to half-empirical to data-driven models and the underlying battery aging testing methods provide a toolchain to predict the battery lifetime for individual xEVs according to their specific driving usage.

**16:20 Q&A**

**16:35 Closing Remarks**

**16:40 Close of Conference**

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# EV TECHNOLOGY FOR SPECIALTY APPLICATIONS

## Commercializing Advanced High-Energy Batteries for Heavy & Light EVs

**WEDNESDAY, 15 JANUARY****8:00 Conference Registration & Morning Coffee****PLENARY SESSION: xEV MARKET EXPANSION****8:40 Chairperson's Opening Remarks***Menahem Anderman, PhD, President, Total Battery Consulting, Inc.***8:45 The Path to Zero-Emission Road Transport in Norway: Past Incentives and Future Goals***Sigve J. Aasebo, Senior Advisor, Norwegian Public Roads Administration*

Zero emission transport is a cost-effective measure to reduce carbon emissions. Incentives for electrification started out in 1990 and have been both long-term and increasing with time. The goals of 2025 are to stop selling vehicles with ICE in passenger cars, city busses and light-weight vans. By 2030, no heavy vans with ICE, and maximum 25% of long-distance busses and 50% of new HDV with ICE. Will Norway reach the world's most ambitious goals?

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The presentation will analyze the current global battery market and provide some forecast for Lithium-ion batteries and their impact on the supply of raw materials.

**9:25 Cathode Market Expansion: Challenges and Opportunities***Tom van Bellinghen, Marketing & Sales Director, Rechargeable Battery Materials, Umicore*

EV penetration of somewhere between 1 and 2 % has turned cathode landscape upside down. How to prepare for the 100\$/kWh, when price parity with ICE will be reached and the real growth will start? Decreasing cost, increasing energy density, improve product purity, ensuring raw material availability and upstream mining investments, while guaranteeing ethical and environmental standards, all at a lower CO2 footprint: a lot of balls to keep in the air.

**9:45 Sustainability in the Battery Value Chain***Jonas Augustin, Engagement Manager, McKinsey & Company, Inc.*

Batteries are a key enabler to electrify transport and realize the energy transition. The tremendous growth in demand for batteries will, however, impose a number of economic, environmental, and societal challenges to the entire value chain from raw material mining all the way to end-of-life. A sustainable scale-up of the battery value chain is required to ensure the positive impact of batteries. Circular economy and responsible practices will be a core part of the solution.

**10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)****11:00 The Big Question about PHEV vs. BEV – What Does the Actual Trend Suggest?***Viktor Irlé, Market Analyst, EV-Volumes.com*

This presentation will look at PHEVs and BEVs from a global perspective but also focus on Europe in more detail. It will examine what the actual data suggests, who the active OEMs are in the field, which models are the best sellers, how Chinese policy influences what European automakers bring to the market, and how the near-future forecast on BEV vs. PHEV looks.

**11:25 Chinese xEV Market: Vehicle, Battery, and Materials Impact***Mark Lu, PhD, Certified Senior Industrial Analyst, ITR, Taiwan***11:55 Q&A****12:20 Networking Lunch (Sponsorship Opportunity Available)****13:30 Dessert Break with Exhibit & Poster Viewing****SPECIALITY MARKET OVERVIEW****14:15 Chairperson's Remarks***Stefan Kamm, PhD, Director, E-Powertrain Development, MAN Truck & Bus SE***14:20 Commercial Developments of LMP Technology in Mobility and Stationary Domains***Didier Marginedes, Senior Vice President, Director, BlueSolutions – Groupe Bolloré*

Urban mobility is one of the toughest challenges that cities face today as existing mobility systems are not responding to the new needs. Evolution of travel habits, demand for new services, speed and predictability, as well as evolving customer expectations toward individualization and sustainability will require new mobility services. BlueSolutions intends to be part of this evolution with car-sharing services and public transportation solutions based on its battery technology and systems solutions.

**14:40 The Emerging Battery Markets beyond xEV – Development of Special EVs and Mobile Applications***Axel Thielmann, PhD, Deputy Head of the Competence Center, Emerging Technologies, Fraunhofer Institute for Systems and Innovation Research ISI*

The talk will provide an updated overview of the emerging battery markets beyond xEV. The status of battery market demand and future dynamics of commercial electric vehicles, buses, trucks, ebikes, industrial to stationary applications will be discussed. How do key battery performance parameters develop, and which battery technology will be suitable for the upcoming applications? Which are the main cell producers and OEM and how do the markets develop compared to the xEV market?

**HEAVY ELECTRIC VEHICLE (HEV) BATTERY SYSTEMS****15:00 Design of the MAN E4C Battery***Sebastian Kratzer, Electric & Electronic Hardware ePowertrain (EEHP), Teamlead Development Energy Storage Systems, MAN Truck & Bus SE*

MAN just launched its full electric E4C busses, offering a 480kWh in the 12m and 640kWh in the 18m low floor city bus. In this talk we like to give a design overview of the E4C Battery System and also some interesting test data, e.g. from safety and cycle life testing.

**15:20 Sponsored Presentation (Opportunity Available)****15:40 Refreshment Break with Exhibit & Poster Viewing****16:30 Electro-Thermal Modelling & Simulation of Li-Ion Battery Packs for Heavy-Duty xEVs***Jens Groot, PhD, ESS Specialist, Cell Characterisation & Modelling, ESS System Design & Architecture, Volvo Group Trucks Technology (GTT)*

Heavy-duty xEVs such as buses and trucks use very large energy storage systems of several hundred kWh distributed over several battery packs. This presentation will cover some recent research activities within the Volvo Group related to electrochemical-thermal simulations on cell level and simplified electro-thermal modelling on module & pack level as well as application examples: recent R&D and eMobility within Volvo Group.

**16:50 EDLC Lifetime Holistic Estimation for Heavy-Duty Applications***Inigo Gandiaga, Researcher, Energy Storage and Management, Ikerlan, Spain*

A model for EDLC lifetime estimation will be presented. It was developed based on long-term experimental aging tests: more than 6 years for the calendar tests, and more than 2,000,000 cycles for the cycling tests. Real application simulation tests were based on Kaohsiung (Taiwan) route, which was developed by CAF and became the first OESS based 100% catenary free operation tramway in the world.

**17:10 Challenges for HD xEVs***Fernanda Lodi Marzano, PhD, Development Engineer, Materials Technology R&D, Scania*

The electrification of heavy-duty transportation is picking up speed and is driven by several factors, among them are increased emission regulations. One tempting approach is to leverage the passenger car industry's technology, supply chain and scale for heavy-duty transportation vehicles. However, there are key differences in requirements and operating conditions between



passenger car and HD xEVs. This presentation will cover recent research activities within Scania evaluating and testing battery technology from passenger cars to HD xEV applications.

17:30 Q&A

18:00 Close of Day

## THURSDAY, 16 JANUARY

7:30 Conference Registration

8:00 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.

## HEAVY ELECTRIC VEHICLE (HEV) BATTERY SYSTEMS (CONT.)

9:00 Chairperson's Opening Remarks

Wasim Sarwar, PhD, Technical Specialist – Battery Systems, Williams Advanced Engineering

9:05 E-Bus Battery Market 2020

Shmuel De-Leon, CEO, Shmuel De-Leon Energy, Ltd.

Li-ion battery market is booming – E-Bus Li-ion batteries are responsible for 20% of the overall market growth. This presentation will cover what Li-ion battery technologies are fitting that market, who the main cell makers are and what the market growth is in the far-east, USA and Europe.

9:25 Li-Ion High-Power Batteries for Use in Public Transport Applications – Economical Due to Durability

Jürgen Langwost, Director, Impact Clean Power Technology Deutschland, Germany

Li-ion batteries for public transport embody an entirely different use-case as for personal transport applications. Long journeys and operation hours provide space for specialized solutions. The choice of the optimal cell chemistry should depend on the calculation of total cost of ownership. High-performance LTO batteries have proven in practice that they can cause significant benefits not only to e-buses and their operators.

9:45 Norwegian Introduction and Potential for Battery Electric Ferries

Sigve J. Aasebø, Senior Advisor, Statens vegvesen, Norway

Previously, LNG (gas) was the preferred solution. Now, Norway plans for battery electric ferries on two thirds of the ferries connected to the national and regional roads. Ferries not suitable for pure battery electric drivetrain are planned for hydrogen (one third). Using innovation contracts in public procurement makes for a fast transition in technology. The Norwegian ship building industry is making a shift because of these more than 200 ferries.

## AEROSPACE BATTERY APPLICATIONS

10:05 Ultra-High Energy Metallic Lithium Anode Battery for xEV and Aerospace Applications

Michael Fetcenko, Chairman of the Board, Sion Power

Sion Power has combined our long experience with metallic Li anodes with high energy Li-ion cathodes such as NCM and achieved 500 Wh/kg, 1000 Wh/L with 500 deep discharge cycles. We have scaled up to 6 and 20 Ah large format cells and modules with outstanding and independently verified safety. We have a technology roadmap to achieve 700 Wh/kg and 1400 Wh/L for aerospace applications.

10:25 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

11:10 The eVTOL Battery

Limhi Somerville, Battery Systems Technical Specialist, Energy Storage, Vertical Aerospace

Electric vertical take-off and landing vehicles provide an opportunity to utilise large lithium-ion 'automotive type' battery packs for inter- and intra-city air travel. These will require the very best engineering to maximise available energy and power whilst maintaining the highest-standards of safety. This presentation will discuss some of the demands of this exciting industry on

these battery packs and show initial safety and testing data that underpin key design feature requirements.

## LIGHT ELECTRIC VEHICLE (LEV) BATTERY SYSTEMS & CHARGING

11:30 EV, Battery and Charging Infrastructure Standard Development for LEV Applications

Mo-Hua Yang, General Manager, TD HiTech Energy, Inc.; Vice President, BATSO e.V.

The huge demand of Li-ion battery in the EVs market leads to the Li-ion battery technology developing in the direction of safety and performance improvement. Apart from EVs, LEV as personal mobility received much attention for connection to the public transportation system in the smart and clean city development. The standard and public tender for city to developing public LEV charging infrastructure is also important. The market and the Li-ion battery development trend for LEV application will be discussed in this presentation.

11:50 Light Electric Vehicles in Terms of Battery Safety and Standard Charging Systems

Hannes Neupert, Managing Director, EnergyBus; Operating Agent, International Energy Agency

12:10 Q&A

12:40 Networking Lunch (Sponsorship Opportunity Available)

## EV APPLICATIONS IN MOTORSPORTS

13:40 Chairperson's Remarks

Shmuel De-Leon, CEO, Shmuel De-Leon Energy, Ltd.

13:45 Developing the Next Generation of Battery Technology through Electric Motorsport

Wasim Sarwar, PhD, Technical Specialist – Battery Systems, Williams Advanced Engineering

Williams Advanced Engineering is focused on the development of the world's most energy dense and power dense battery systems through the advancement and implementation of next-generation cell chemistries. This talk will explain how pioneering work on cell development, battery pack design, novel control systems and state-of-the-art state detection combine to enable a step-change in performance for the next generation of battery systems used in electric motorsport.

## GRID-SCALE ENERGY STORAGE

14:05 Vehicle to Grid: System Design and Economic Potentials in Germany

Kai-Philipp Kairies, Director, Technical Consulting, RWTH Aachen University

As the deployment of electric vehicles (EVs) accelerates, new opportunities arise for them to do more than simply provide mobility services. EVs, with their significant storage capacities, can play an important role in stabilizing our electricity grids. Private cars are typically in use for less than 10% of the time, meaning that if they are potentially available to provide services to the grid and generate additional value for their owners. The presentation will outline the technical background and the economic potentials of vehicle to grid operation in Germany based on comprehensive real-life data and considering the most recent regulatory developments.

## SUPERCAPACITOR APPLICATIONS

14:25 The Merits of Standardizing our Energy Storage

Rob Sweney, Technical Program Manager, Tiveni

Developing the energy storage system for a new vehicle is an extremely expensive and challenging process, and may be more of a "barrier to entry" than a source of competitive advantage for vehicle makers. The introduction of "standard" battery modules would help to drive down costs and simplify vehicle development, but must be done in a way that does not stifle innovation in cell chemistry and construction. A new approach to standardization and EV development is discussed.

14:45 Q&A

15:00 Refreshment Break



## **CLOSING PLENARY SESSION: BATTERY LIFE AND RELIABILITY**

### **15:15 Chairperson's Remarks**

*Falko Schappacher, PhD, Member of the Board of Directors, MEET Battery Research Center, University of Muenster*

### **15:20 Li-Ion Battery Life in xEV Applications**

*Falko Schappacher, PhD, Member of the Board of Directors, MEET Battery Research Center, University of Muenster*

### **15:40 Life-Limiting Mechanisms in Li-Ion Automotive Technology**

*Thomas Waldmann, Team Leader Post-Mortem Analysis and Aging Mechanisms, PhD, ZSW*

In order to improve battery life time, the underlying aging mechanisms have to be identified. This presentation gives an overview on Post-Mortem analysis and aging mechanisms in different commercial state-of-the-art cells. The results are complemented with lab cells with reference electrode. The investigated mechanisms include Li deposition, SEI growth, and dissolution of silicate species from Si/C composite anodes. We show how the mechanism of Li plating can be hindered for fast-charging in commercial 16Ah pouch cells.

### **16:00 Development and Validation of xEV Battery Life Models**

*Veronika Obersteiner, PhD, Project Manager IODP, IODP Architecture & Technology, AVL List GmbH*

Battery life has been one of the major obstacles to lithium-ion battery popularity in recent years, as it directly limits the electrical range over the lifetime of the xEV. Therefore, efficient methods for characterizing the complex process of battery ageing are needed. Utilizing these models for the development of strategies to analyze the battery degradation can enable a significant extension of the xEV's life. Current modeling approaches, ranging from electro-chemical to half-empirical to data-driven models and the underlying battery aging testing methods provide a toolchain to predict the battery lifetime for individual xEVs according to their specific driving usage.

### **16:20 Q&A**

### **16:35 Closing Remarks**

### **16:40 Close of Conference**



# GLOBAL BATTERY RAW MATERIALS

Balancing Supply, Demand & Costs for Battery Component Materials

WEDNESDAY, 15 JANUARY

8:00 Conference Registration & Morning Coffee

## PLENARY SESSION: XEV MARKET EXPANSION

8:40 Chairperson's Opening Remarks

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

8:45 The Path to Zero-Emission Road Transport in Norway: Past Incentives and Future Goals

*Sigve J. Aasebo, Senior Advisor, Norwegian Public Roads Administration*

Zero emission transport is a cost-effective measure to reduce carbon emissions. Incentives for electrification started out in 1990 and have been both long-term and increasing with time. The goals of 2025 are to stop selling vehicles with ICE in passenger cars, city busses and light-weight vans. By 2030, no heavy vans with ICE, and maximum 25% of long-distance busses and 50% of new HDV with ICE. Will Norway reach the world's most ambitious goals?

9:05 The Battery Market and Main Trends 2020-2030

*Christophe Pillot, Director, Avicenne Energy*

The presentation will analyze the current global battery market and provide some forecast for Lithium-ion batteries and their impact on the supply of raw materials.

9:25 Cathode Market Expansion: Challenges and Opportunities

*Tom van Bellinghen, Marketing & Sales Director, Rechargeable Battery Materials, Umicore*

EV penetration of somewhere between 1 and 2 % has turned cathode landscape upside down. How to prepare for the 100\$/kWh, when price parity with ICE will be reached and the real growth will start? Decreasing cost, increasing energy density, improve product purity, ensuring raw material availability and upstream mining investments, while guaranteeing ethical and environmental standards, all at a lower CO2 footprint: a lot of balls to keep in the air.

9:45 Sustainability in the Battery Value Chain

*Jonas Augustin, Engagement Manager, McKinsey & Company, Inc.*

Batteries are a key enabler to electrify transport and realize the energy transition. The tremendous growth in demand for batteries will, however, impose a number of economic, environmental, and societal challenges to the entire value chain from raw material mining all the way to end-of-life. A sustainable scale-up of the battery value chain is required to ensure the positive impact of batteries. Circular economy and responsible practices will be a core part of the solution.

10:10 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)

11:00 The Big Question about PHEV vs. BEV – What Does the Actual Trend Suggest?

*Viktor Irlé, Market Analyst, EV-Volumes.com*

This presentation will look at PHEVs and BEVs from a global perspective but also focus on Europe in more detail. It will examine what the actual data suggests, who the active OEMs are in the field, which models are the best sellers, how Chinese policy influences what European automakers bring to the market, and how the near-future forecast on BEV vs. PHEV looks.

11:25 Chinese xEV Market: Vehicle, Battery, and Materials Impact

*Mark Lu, PhD, Certified Senior Industrial Analyst, ITR, Taiwan*

11:55 Q&A

12:20 Networking Lunch (Sponsorship Opportunity Available)

13:30 Dessert Break with Exhibit & Poster Viewing

## RAW MATERIALS GLOBAL ENVIRONMENTAL IMPACT

14:15 Chairperson's Remarks

*Anne Oxley, Technical Director, Brazilian Nickel*

14:20 ESG and the Environmental Cost Curve: Can the Mining and Processing of Battery Raw Materials Fulfill the Promise of a 'Green' Electric Vehicle, and What Is the True Cost?

*Robert Baylis, Managing Director, Roskill*

Corporate social responsibility (CSR) has been front-and-centre in supply chain issues surrounding electric vehicle battery material sourcing, not least cobalt extraction in the DRC, environmental, social and governance (ESG) is fast becoming the latest compliance metric in OEM, supplier and investor decisions. This presentation looks at ESG issues within the battery raw material landscape, and why a new approach to the cost curve including emissions to air/land/water that are not currently part of conventional cost modelling and its potential raw material cost/pricing impact is needed to establish just how 'green' electric vehicles can become.

## BATTERY RAW MATERIALS SUPPLY

14:40 The Age of the Lithium-Ion Battery Megafactory – Who Is Winning the Global Battery Arms Race

*Caspar Rawles, Senior Analyst, Benchmark Mineral Intelligence*

Since 2014, Benchmark Mineral Intelligence has tracked the global build-out of large-scale lithium-ion battery production capacity, termed battery 'megafactories'. This presentation will focus on where current capacity sits, where capacity will be added in the future and who looks to be winning the global battery arms race. Furthermore it will review the raw material demand implications to feed these plants, the cathode technology they will be using and if the supply side of the market can keep up.

15:00 European Lithium – A Significant Contributor to a Sustainable Battery Value Chain in Europe

*Franz Josef Kruger, PhD, Senior Advisor, European Lithium Limited (Australia); ECM Lithium GmbH (Austria)*

European Lithium aims to become the first battery-grade lithium producer in an integrated European battery supply chain by developing the Wolfsberg Lithium Project in Austria. Combining state-of-the-art technology with sustainable production, European Lithium is set to fuel the future of the European electromobility.

15:20 Lowest Cost, Longest Life Li-Ion Cells with Advanced Anode Graphite

*Jeremy Schrooten, PhD, Technical Director, Pyrotek, Inc.*

Pyrotek is pushing the limits of graphite. New in-house 18650 cell data confirmed by independent laboratories demonstrates industry-leading metrics enabling devices to last longer and batteries to cost less. With production in the USA, Pyrotek is leading the industry in delivering high-performance materials with low environmental impact.

Sponsored by  
**Pyrotek**

15:40 Refreshment Break with Exhibit & Poster Viewing

16:30 How Is Europe Positioned in the Global Lithium Race?

*Vincent Ledoux Pedailles, Executive Director, Corporate Strategy, Infinity Lithium*

There is a fantastic momentum around the development of electric vehicles across the world and Europe is investing billions of euros to transform its auto industry and become a leader in electrified mobility. The continent is also starting to welcome large investments for lithium-ion battery factories, but further upstream, in lithium mining and refining, Europe is lagging behind. Infinity Lithium and its San Jose project in Extremadura, Spain, represents a strategic investment supporting the development of a more integrated and regionalised lithium-ion battery and auto industry.

**16:50 Sustainable Lithium for a World in Motion***Bart Vanden Bossche, Director, SQM***17:10 Production of Lithium Hydroxide at Lower Cost***Jean-François Magnan, Technical Manager, Nemaska Lithium*

Nemaska proprietary technology allows to produce lithium hydroxide directly at a lower cost than most of the actual lithium carbonate producers. Lithium hydroxide is required for the production of high-grade nickel cathode material having high energy density such as NCA and NMC. Also, depending on the chemistry and the process to synthesize the cathode material, lithium hydroxide has many technical advantages over lithium carbonate.

**17:30 Q&A****18:00 Close of Day****THURSDAY, 16 JANUARY****7:30 Conference Registration****8:00 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 RAW MATERIALS SUPPLY****9:00 Chairperson's Opening Remarks***Robert Baylis, Managing Director, Roskill***9:05 Heap Leaching – Creating Nickel Supply Solutions***Anne Oxley, Technical Director, Brazilian Nickel*

With demand for battery raw materials set to soar over the next decade, where will we find so much new nickel (& cobalt) supply? Notoriously capital intensive, with problematic and slow ramp-ups, complicated HPAL is not the answer. Nickel laterite heap leaching is simple, flexible, low cost and is now ready to unlock the many known, but to date, uncommercial nickel laterite projects. BRN's Piauí Nickel Project is set to be the first.

**9:25 Ni Market Update 2020-2025 – Would It Be Enough Ni to Feed the Growing Battery Market?***Denis Sharypin, Head of Market Research, MMC Norilsk Nickel*

The talk will focus on Ni demand projections by industry, update on Indonesian Ni projects. Possible impact of the Indonesian export ban will be elaborated and the Ni incentive price for bringing additional Ni units to the market will be examined.

**9:45 Progress Update: Green, European, Ultra-High-Purity Manganese Products Made by Recycling Mine Waste***Marco Romero, CEO, Euro Manganese*

The Chvaletice Manganese Project is rapidly advancing to become Europe's only primary producer of ultra-high purity manganese products for production of NMC cathode EV battery production. These will be made by recycling waste and with an exceptional environmental footprint.

**10:05 Challenges and Opportunities for Cobalt Supply in the Democratic Republic of Congo***George Heppel, Senior Analyst, Cobalt, Lithium & Battery Markets, CRU Markets*

The Democratic Republic of Congo holds the same sway over the cobalt market as Saudi Arabia does for oil, or China does for rare earths. CRU estimates that by next year, over 75% of global cobalt supply will come from the DRC, and this is set to only increase in the coming years. But while the DRC represents a huge supply potential for the cobalt market, it comes with many underlying risks – spanning from political and legislative risk, to infrastructural risks, and of course the ethical risks associated with artisanal mining. If left unchecked, these risks could be hugely detrimental to the global expansion of e-mobility.

**10:25 Coffee Break with Exhibit & Poster Viewing (Sponsorship Opportunity Available)****11:10 Sustainability in the Cobalt Supply Chain***David Weight, President, Cobalt Institute*

The presentation will look at the historical changes to the cobalt market over the past 20 years, noting specifically the impact that cobalt containing Li-ion battery development has had while looking at the challenges cobalt faces in the global marketplace, from chemical management to responsible sourcing.

**11:30 Advanced Conductive Agents, Including DENKA BLACK, Tailored to Automobile Applications**Sponsored by  
**Denka***Akira Yoda, MA, Researcher, Battery and Conductive Materials Development Department, Denka Company Limited*

In order to increase zero-emission vehicles usage globally, there remain various tasks to improve battery properties. One of these important tasks concerns "Range". We have identified that advanced conductive agent (including acetylene black) amounts in batteries can be reduced when Denka Black is used.

**11:50 Upgrade your Polymers Choice to Improve for your Higher Performance Li Ion Batteries**

Sponsored by

*Rui Liu, Global Marketing Manager – Batteries, Solvay Specialty Polymers*

With continuous need of improvement of Li-ion battery technology, polymers used in your battery cell, module and pack are becoming more and more important to push safely the extra mile of your battery performance. From separator coating to cell gaskets, Solvay Specialty Polymers offers high performance polymers with high temperature rating, excellent chemical and electrochemical stability for higher safety and longer cycle life.

**12:10 Q&A****12:40 Networking Lunch (Sponsorship Opportunity Available)****GLOBAL MARKET DEMAND FOR BATTERY RAW MATERIALS****13:40 Chairperson's Remarks***Vincent Ledoux Pedailles, Executive Director, Corporate Strategy, Infinity Lithium***13:45 Pricing and Price Outlook for Battery Raw Materials***William Adams, Head of Battery Research, Fastmarkets Research*

A look at the different ways lithium and cobalt are priced and how that is likely to evolve – so from 1 to 1 pricing, to pricing via a PRA, to exchange pricing. Why the downstream supply chain is likely to demand this pricing evolution. And, the look at the outlook for cobalt and lithium supply/demand and prices.

**14:05 Breaking the Raw Materials Supply Barrier***Milan Thakore, Research Analyst, Battery Raw Materials, Wood Mackenzie*

Under the most conservative EV forecasts, battery raw materials supply acts as a barrier to greater EV penetration. Mines and refineries require time and investment. This currently falls short but is also concentrated in certain regions. We look at what needs to happen to enable the EV revolution, from new metals supply frontiers, CAPEX requirements to realistic technology timelines.

**14:25 Raw Materials Post 2025 – Where Will They Come From?***Andrew Leyland, Head of Strategy & Forecasting, Benchmark Mineral Intelligence*

From 2025 to 2030 supply of lithium-ion battery raw materials will need to almost double in order to keep up with projected demand. Against this backdrop, most raw material markets also witnessed price declines over the course of 2019 that make financing that supply almost impossible. This presentation will look at the implications of the lack of project finance to date on being able to fill the structural deficits opening up in the lithium, cobalt, nickel and graphite markets. We will also consider the price levels required to make supply economically viable, and the impact that these price levels will have on average NCM 811 cell costs.

**14:45 Q&A****15:00 Refreshment Break**



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### **16:20 Q&A**

### **16:35 Closing Remarks**

### **16:40 Close of Conference**

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Students\* presenting a poster can attend AABC Europe for as little as €299.

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Friedrich-Ebert-Allee 1  
65185 Wiesbaden, Germany

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## PROGRAM SELECTIONS

	Sunday 12 January	Monday 13 January	Tuesday 14 January	Wednesday 15 January	Thursday 16 January
INTERACTIVE TUTORIALS	SYMPOSLIA		CONFERENCES		
Tutorials: See page 3	S1: CHEMISTRY		C1: HYBRID & ELECTRIC VEHICLES		
	S2: ENGINEERING		C2: SPECIALTY/PUBLIC TRANSPORT EVs		
	S3: LEAD-BASED		C3: RAW MATERIALS		
	S4: RECYCLING				
Dinner Tutorials: See page 3					



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ENDS 10 JANUARY**

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

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