

# BATTERY POWER

Solutions for OEM Design Engineers, Integrators & Specifiers of Power Management Products

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Volume 14, Issue 4

## 2010 Resource Guide

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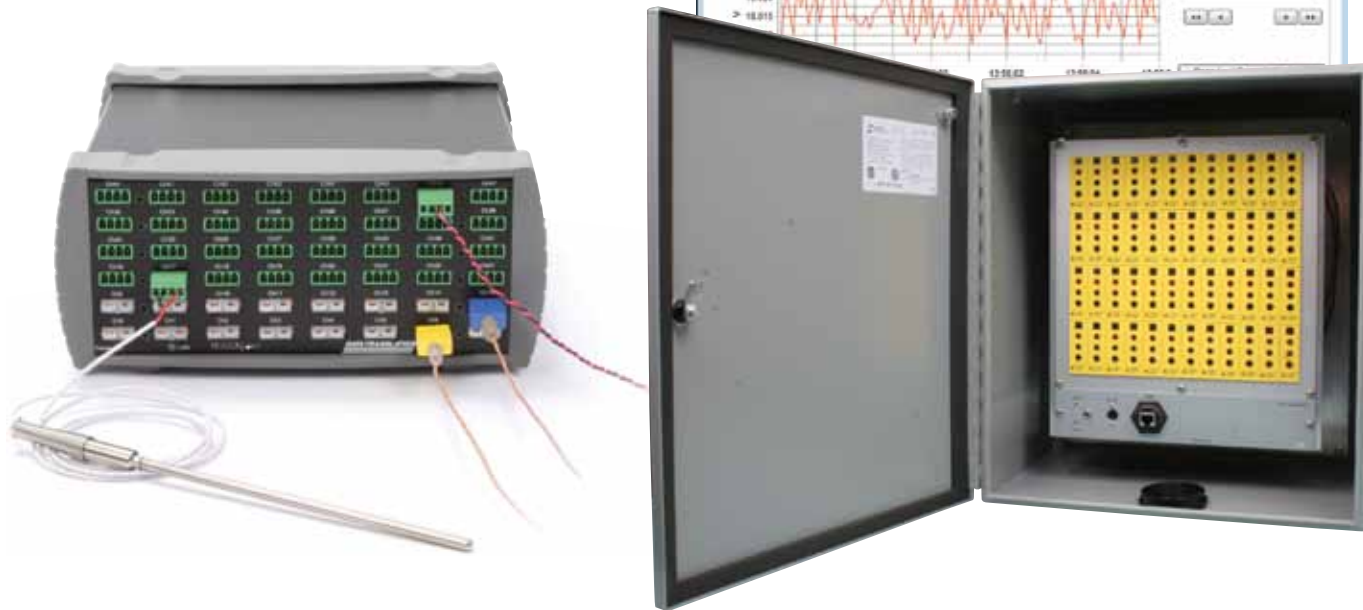
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## Inside this issue of **BATTERY POWER**

Solutions for OEM Design Engineers, Integrators & Specifiers of Power Management Products

## 2010 Resource Guide

Welcome to the 2010 Battery Power Resource Guide. Within these pages you will find listings of manufacturers and suppliers in the battery industry and the products and markets they serve. Batteries are categorized by chemistry and type for easy reference. The guide also covers battery supplies; from accessories and consulting services to recycling and watering systems.

Frost & Sullivan has contributed an article on the global battery market and Palladium Energy has written on the future of lithium-based batteries. There is also a preview of Battery Power 2010 starting on page 32.

We hope you will find the 2010 Resource Guide a useful reference tool. As always, we welcome your feedback.

Shannon Given, Director of Content  
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## Analyzing the Global Battery Market

**Vishal Sapru, Industry Manager – Energy & Power Systems**  
Frost & Sullivan

A battery can be defined as an energy storage device capable of converting chemical energy into electricity. The conversion of chemical energy into electricity is brought on by chemical reactions that transfer the charge between the electrode and the electrolyte at their interface. These reactions are termed as 'faradaic' reactions and are responsible for the flow of current through the cell. Batteries can be divided into two categories: primary and secondary. Primary batteries are disposable batteries that are meant to be used once and then discarded. They find common use in portable devices. Secondary batteries are capable of being recharged after being drained. This is accomplished by the application of externally supplied electric current that reverses the electrochemical reactions.

Most of the applications either portable or non-portable, often require a power source. The most favorable is a battery that provides power when needed on demand. Batteries have been known to power a wide range of applications, from medical portable devices, backup power for PCs, automotive applications, military and aerospace applications, mobile communication devices, grid stabilization, solar/wind storage and oil & gas applications among others. Batteries are classified by the chemistry that drives the electrical reaction such as lead acid, lithium, nickel, alkaline and zinc. As one of the most relied upon aspects of a system, the battery must be able to perform specific functions, adhere to strict weight limits, and above all be a safe system to operate in various situation including abusive scenarios (drops, vibrations and extreme temperatures).

With equipment design demands putting additional and increasing demands on the battery, existing battery chemistries are challenged to maintain performance levels or are extended beyond their operation levels. Many alternative energy storage solutions are under development, poised to become next generation power source or to be used in conjunction with existing batteries to extend run time. These technologies include fuel cells, advanced lithium designs, ultracapacitors and nickel zinc.

### Market Forecast

In 2009, the global batteries market was estimated at \$47.5 billion. This is likely to reach \$74 billion in 2015. This growth can be attributed to the high demand for rechargeable batteries that commands 76.4 percent of the global battery market. The primary batteries contribute 23.6 percent. The rechargeable market is likely to dominate the global batteries market in 2015 with 82.6 percent of the total revenues. The primary battery market will contribute 17.4 percent.

Portable devices such as notebook and laptops, sleek and ultra thin mobiles and the like are the current trends in the consumer electronics market. This has directly translated into a need for batteries that are compact and lightweight to enable portability. Batteries that are minute and lightweight with long life and high energy density are the present day requirements. Consumer electronics is not the only industry where portability is catching up. Medical devices too are on the way toward miniaturization spurred by trends such as growing alternative care facilities and public access devices market.

The battery market for military and aerospace applications is dynamic. Factors such as stringent regulations and ever-increasing demands govern the developments in battery technologies. Battery technologies are faced with the growing issue of keeping in pace with sophisticated aircraft and military equipment that are being developed.

Batteries are crucial to automobiles. Advanced battery technologies are used in plug-in hybrids that are capable of being charged overnight to power the vehicle for short trips. The ever-increasing fuel costs combined with an increasing focus on energy

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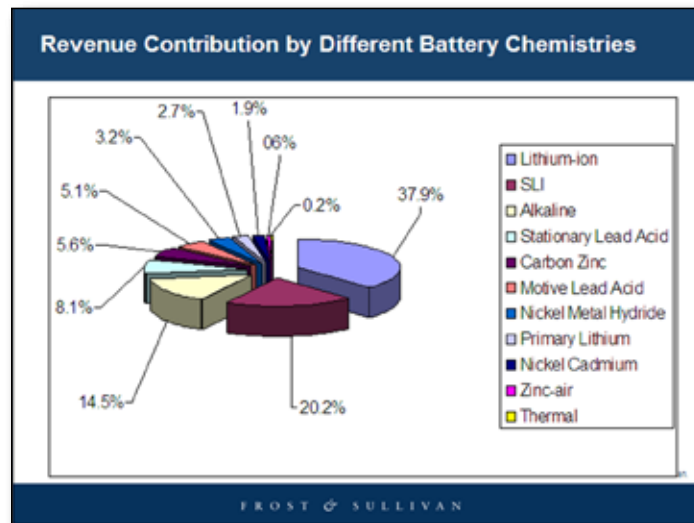


Chart 1 illustrates the revenue contribution by different battery chemistries in 2009.

efficient systems is resulting in automotive consumers opting for hybrid vehicles owing to their ability to lower the pollution by half and be twice as fuel efficient. This has increased the interest in developing battery technologies for use in these vehicles.

With devices being increasingly made available for public use, features such as ease of operation and lighter weight are gaining importance. This has resulted in battery manufacturers working towards developing batteries that are lighter weight, have higher energy density, higher efficiency of charge/discharge and a longer life cycle.

**Battery Market Life Cycle**

Overall, the battery market is at the mature stage of growth. Chart 2 depicts lithium chemistries on the growth curve as it is newer chemistry amidst the other chemistries. Also, lithium has high energy density, light weight and low self discharge. nickel cadmium and carbon zinc chemistries are on the declining curve as interest has grown in the use of nickel metal hydride, as well

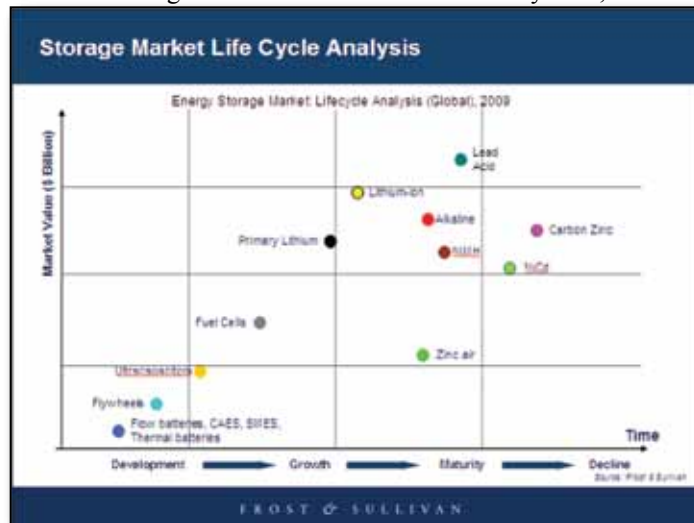


Chart 2 shows the market life cycle of different battery chemistries in 2009.

as lithium and alkaline chemistries. Lead acid battery technology is in the mature growth phase as it is the technology that has sustained the concept of energy storage for more than a century. Upcoming battery technologies such as flow batteries and thermal batteries are gaining interest but are still in the development phase.

**Emerging Battery Chemistries**

There are significant measures being taken in future battery development. Some of the emerging battery technology includes the following:

**Lithium-Air Batteries:** is a combination of lithium metal that acts as an anode, while the surrounding air acts as cathode. Cathode element absorbs the oxygen from the atmosphere, thereby making these batteries much lighter than lithium-ion and primary lithium batteries. Currently, these batteries are non-rechargeable, similar to zinc-air batteries. However, research is in the ongoing stage to develop rechargeable lithium-air batteries. The concept of lithium-air batteries existed almost two decades earlier. The drawback of lithium metal reacting rapidly and violently even with traces of water, which may lead to serious safety hazard, prevented development and commercialization of these batteries. Hence, these batteries were considered unsafe for large-scale commercial use. The advantage of such chemistry includes higher density, low cost and light weight.

Manufacturers such as PolyPlus and Excellatron Solid State LLC are working to develop Lithium-air batteries. Institutions such as MIT, AIST (The National Institute of Advanced Industrial Science and Technology) are also contributing towards the development of this chemistry.

**Lithium Sulphur Batteries:** has gained attention in the hybrid electric vehicle and electric vehicle (HEV/EV) industry. Although scientists have been working on this chemistry for nearly a decade, only recently has a rechargeable lithium sulphur battery been developed for mass production. The team of scientists from the University of Waterloo has created much anticipation and curiosity, specifically in the automotive industry, with the development of this chemistry.

A lithium sulphur battery is likely to provide the right solution for the two key issues that challenge the demand for lithium-ion batteries in HEV and EV. Lithium sulphur batteries are likely to be available at a much lower price and with higher energy density compared to lithium-ion batteries. Lithium sulphur batteries offer almost three times the energy density as the current lithium-ion batteries. This allows these batteries to run more than 300 miles on a single charge in a passenger electric vehicle. Sulphur is abundantly available, so that reduces the cost of these batteries, thereby making it much more affordable than lithium-ion batteries. These features make lithium sulphur batteries a better choice over lithium-ion batteries. These batteries are environmentally friendly due to their biodegradable components.

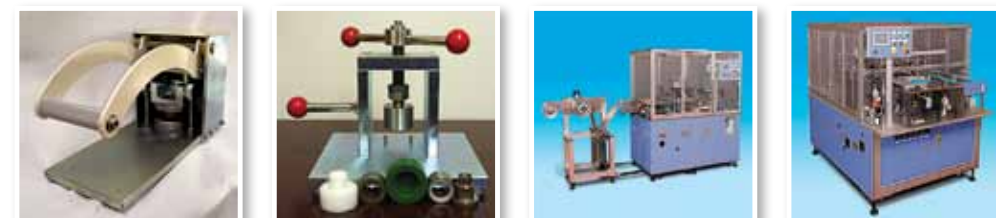
Manufacturers such as Sion Power, Oxisenergy and Polyplus Battery Company focus on providing a solution to automotive

Frost & Sullivan continued on page 8



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## MARKET TRENDS

and industrial sectors. Polyplus and Sion Power have entered in an agreement to work jointly. Through this agreement, Sion Power is harnessing lithium sulphur chemistry with cooperation from Polyplus Battery Company, while Polyplus is focusing on lithium air and lithium seawater technologies. Scientists at the University of Liverpool are also involved in the development of lithium sulphur battery chemistry.

**Silver Oxide Batteries:** is a primary cell (although it may be used as a secondary cell). Silver oxide batteries have a long life and very high energy/weight ratio, but a prohibitive cost for most applications due to the high price of silver. They are mostly used in watches and military applications. The silver oxide rechargeable batteries are a better option than lithium-ion batteries, but they are as expensive as silver and no financial incentives or support is given from the government as it is not a clean energy technology.

Companies must create a technological breakthrough to capture a major market or carve its own niche segment by offering batteries for specific applications. Silver oxide batteries have several advantages over lithium-ion batteries, especially in notebook computers and cell phone applications such as high run time and high energy to weight ratio.

Manufacturers such as Zpower are partnering and making joint ventures with other companies and government bodies to tap into this market/chemistry.

**Sodium Sulphur Batteries:** is a type of molten metal battery constructed from sodium and sulfur. This type of battery has a high energy density, high efficiency of charge/discharge and long life cycle and is fabricated from inexpensive materials. However, because of the operating temperatures of 300°C to 350°C and the highly corrosive nature of the sodium polysulfide, such cells are primarily suitable for large-scale non-mobile applications such as grid energy storage. Companies may look at these batteries as energy storage systems in electric vehicles in near future.

Some of the advantages of this chemistry include low cost, available in abundance and not harmful.

### Conclusion

Reviewing the historical trends in the battery industry, there are two key features that determine whether battery chemistry will be adopted. These include bottom line cost and proven product safety. A high level of development surrounds these issues, both from established high volume battery manufacturers, as well as emerging market participants. The global battery market will continue to evolve with chemistries like lithium-ion contributing to its growth. With the acceptance and commercialization of emerging technologies, the global battery industry is on the path to continued growth.

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## Lithium-Based Batteries: The 20 Year Discovery

**Dr. Kerry Lanza, Marketing Manager**  
Palladium Energy

The term "lithium-based battery" refers to a family of different battery chemistries, comprising many types of cathodes and electrolytes. It is hard to remember a time without them. Sleek, glamorous and alluring; the building blocks of our technological society and infrastructure, they are used in everything from hearing-aids to vehicles. Nevertheless, they are expensive, temperamental, potentially dangerous and scarce. Today, lithium-based batteries are synonymous with portable power.

History has proven that it takes at least two factors for a technology to be widely adopted: bottom line costs and product safety. Of the group of lithium-based technologies, lithium-ion batteries in particular meet both of those criteria. However, it has not always been that way. A lithium-ion battery cell has been defined as "a wild animal that has to be tamed." Up until a relatively short time ago, lithium-ion battery packs were not a viable solution for portable power. Only since the 1990s have advances in engineering design technologies and battery control components allowed for widespread and safe use of lithium-ion battery packs. First developed in the 1970s, it was not until 1991 that Sony introduced the first rechargeable lithium-based battery, which changed the landscape of electronic product designs.

Soon after commercialization, lithium-ion batteries became widely adopted as batteries for portable consumer products such as notebook PCs and mobile phones. Today, lithium-ion batteries account for two-thirds of all rechargeable batteries used for consumer applications; a significant accomplishment in 20 years. So, what will be the next 20 year discovery?

### The Next 20 Years

Since they are lightweight and have a high charge-density, lithium-based batteries are ideal for portable applications. While we are seeing lithium-based in Electric Vehicles (EVs), what is preventing lithium-based technology from becoming more common in large-format and large-scale commercial applications replacing the ubiquitous lead-acid battery or nickel-based batteries? For starters, electricity and energy are not easily stored, and like other technologies, lithium-based batteries use the process of electrochemistry to accomplish that goal. Employing lithium that has a small specific gravity and high electrochemical reactivity as constituent material, lithium-based batteries can store two to three times the energy of nickel-based batteries. Researchers find there are several factors that must be considered for taking lithium-based to the next step: energy and



cell capacity, low-temperature performance, the low probability of achieving the 15-year lifetime goal, operating temperature at -55°C to 80°C range, safety associated with thermal abuse and cost reduction<sup>1</sup>. Of all, cost and safety appear to be the main limiting factors to success, even if all other criteria are met.

### Safety

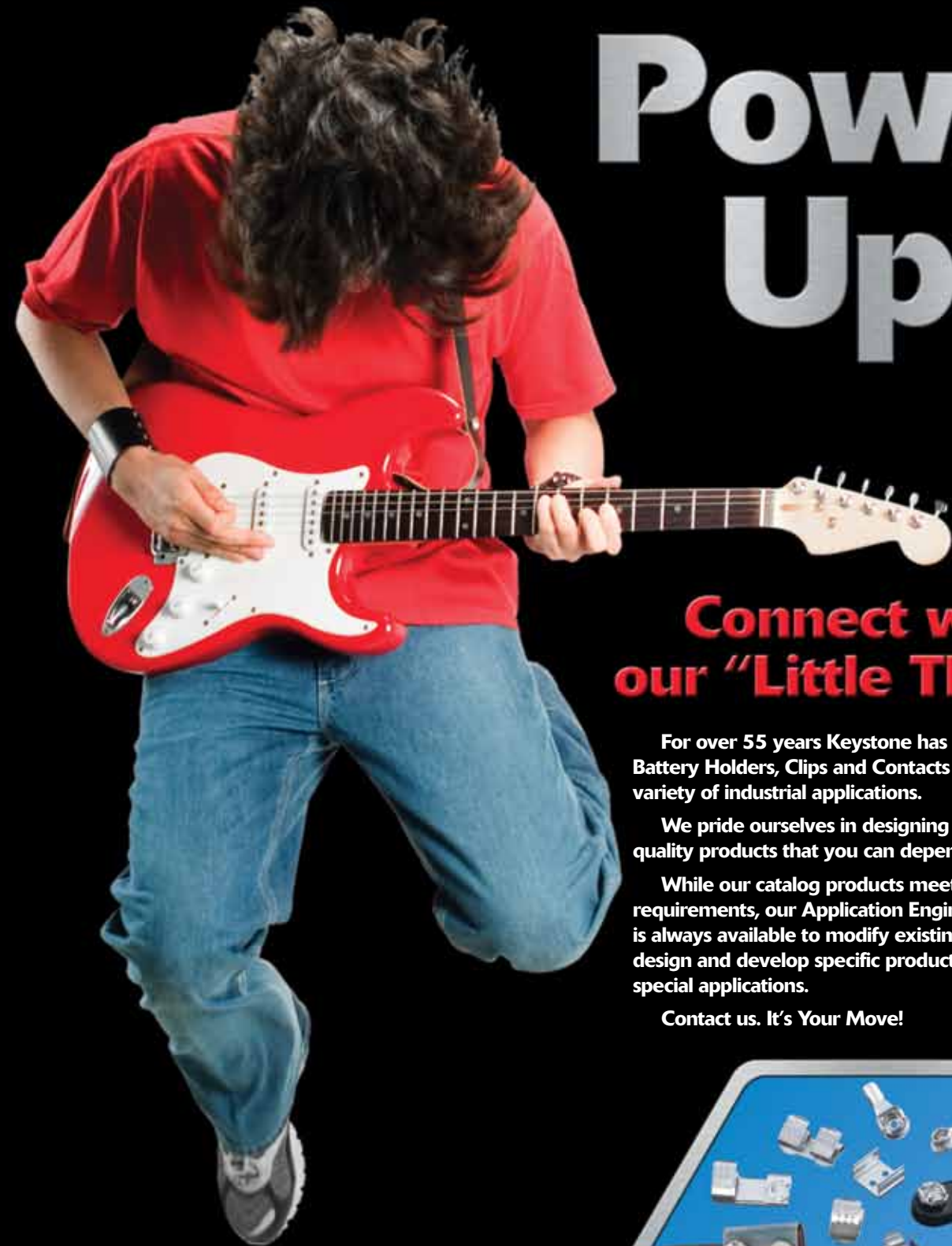
Battery safety is of critical importance as sales of lithium-based batteries depend on consumer confidence. For large format batteries, safety problems increase at a disproportionately greater rate. Abnormal heating and fire caused by lithium-ion batteries is called "thermal runaway." Basically, in some extreme cases, internal materials inside the battery overheat, causing excessive energy transfer to internal components. As internal temperatures continue to rise, the battery reaches an overheated state and may catch fire. The main causes for thermal runaway are internal short circuits, overcharging of batteries, or the compounded factors. In case of an internal short circuit, a burst of electric current rushes through the anode and generates abnormal heating. The heated anode then heats up the cathode, which develops an exothermic reaction.

Overcharging, on the other hand, leads to the heating of the cathode side. In charging a lithium-ion battery, lithium ions are pulled out of the cathode material and inserted into the anode material. However, in this process, the cathode material from which lithium ions are extracted becomes unstable in terms of crystal structure. In usual circumstances, lithium-ion batteries are controlled so that the amounts of lithium ions extracted from the cathode do not go beyond a certain level. In case of overcharging, an excessive level of lithium ions is pulled out and this leads to the collapse of the crystal structure of the cathode material, during which the cathode develops exothermic reaction.

### Cost

The United States Advanced Battery Consortium (USABC) has set a goal in terms of dollars per kilowatt-hour (\$/kWh) that lithium battery technology may need to reach to make large format applications commercially viable. The goal is set at \$200 to \$300/kWh. When compared to the current costs of \$700 to \$1,000/kWh<sup>2</sup> and when judged against older technologies, it is believed that lithium-based batteries still have significant potential for cost reductions. The cost of a lithium-based battery cell is strongly influenced by the cost of each individual component. Primary cost drivers include cell manufacturing yield, cathode material, the lithium salt used in the electrolyte and the anode

*Palladium Energy continued on page 12*



# Power Up!

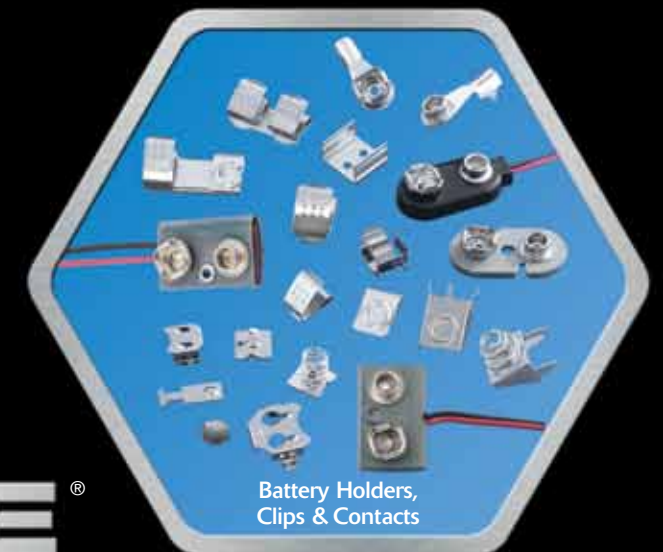
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material costs.

If substantial cost reductions are to be achieved, it must be accomplished by increasing manufacturing efficiencies coupled with reduced component material costs. Cost decreases may happen through the primary mechanisms of battery material technological innovations, economies of scale through increased production volume and breakthroughs in manufacturing processes.

### Possible Lithium Solutions

#### New Cathode Materials

Charging lithium-ion cells to above 4.6 V per cell using traditional lithium metal oxide cathodes and flammable liquid electrolyte cathodes can lead to unsafe events, possible due to lithium deposition or to oxidation of solvents at these high potentials. Replacing the traditional transition metal-oxide cathode materials that use cobalt, manganese or nickel-based oxides with lithium iron phosphate (LiFePO<sub>4</sub> or LFP) or other lithium transition metal phosphates may be a safer alternative. Complete oxidation of LFP occurs at a lower voltage, 3.4 V, and the oxidation product (according to the reaction  $\text{LiFePO}_4 + \text{C}_6 \rightarrow \text{LiC}_6 + \text{FePO}_4$ ) of LFP is ferric phosphate, a stable material<sup>3</sup>. LFP also is very thermally stable up to 300°C, and in an overcharge situation it will not emit oxygen as the metal oxides do. As a result, without oxygen as a thermal runaway precursor, LFP batteries appear safer than traditional lithium-based with thermal runaway less likely.

LFP was first commercialized in 2006 for use in power tools; today LFP is finding use in many other applications taking advantage of its other characteristics. For example, traditional lithium-based batteries have a typical life span of 300 to 400 cycles (charges and discharges), but LFP can be cycled 1,000 times. However, these benefits come at a cost, namely lower energy density. LFP has a typical specific capacity of 140 mAh/g compared to lithium cobalt at 160 mAh/g or lithium manganese cobalt at 180 mAh/g. The nominal voltage of LiFePO<sub>4</sub> based Li-Ion cell voltage is 3.2 V, which is lower than 3.7 V nominal voltage for LiCoO<sub>2</sub> based Li-Ion cell. The net result is that LFP cells take up more space for the same amount of output than alternative chemistries.

#### New Electrolytes

There are new developments in electrolyte salts that are attracting some attention. Lithium Bis(Oxalato)Borate (LiB(C<sub>2</sub>O<sub>4</sub>)<sub>2</sub>), or LiBOB, is gaining some interest because of its ease of manufacture from relatively inexpensive and reliable components, along with its reasonable conductivity in battery solvents. Its main technical advantage is that it is less acidic than LiPF<sub>6</sub> and is more stable when used with lithium manganese oxide. LiBOB has been seen as a safe electrolyte for large-scale lithium batteries. Moreover, it could enable the use of the less expensive lithium manganese oxide spinel instead of the more expensive lithium cobalt oxide.

#### Alternative Technologies

Lithium-based batteries must be viewed in the broader context of the problem they are meant to solve, energy storage. The two leading technologies that can compete with lithium-based are

fuel cells and ultra capacitors. Fuel cells use hydrogen to generate electricity, and therefore must be refueled. No real infrastructure currently exists to support this need. While ultra capacitors are highly efficient, can charge and discharge rapidly, operate at extreme temperatures and have a long life, they suffer from very poor energy density. Nevertheless, it appears that lithium-ion and fuels cells or lithium-based and ultra capacitors may be considered complimentary rather than competing. Many fuel cell applications require battery back-up and capacitors are often used to buffer lithium-ion batteries from high-current events.

### Looking Forward

Indeed, the designs and manufacturing processes used for lithium-based batteries for automobiles and other large format applications are quickly growing, but they represent improvements, not radical changes. At the pack level, the costs per kWh, including safety systems and packaging, are far higher than the \$250/kWh target that would make lithium-ion truly competitive.

However, there is some radical research happening right now. Researchers are using silicon nanowires to basically reinvent the way that the batteries' electrodes work. Instead of using carbon to store the lithium ions in the anode, they are using silicon. Silicon can hold far more ions; however, it actually stores so many ions that it literally swells during charging and contracts during use. That swelling and contraction has generally led to complete destruction of the anode over very little use.

The silicon nanowires allow the anode to absorb the lithium without breaking down. The nanowire "forest" expands to four times its original size during charging, but the wires do not fracture. The batteries could be used to store electricity during off-peak hours or to power portable electronics. Think about the possibilities. If your laptop currently gets two hours of unplugged life, these would get 20 hours. Of course, one never knows what will happen when moving a technology from the lab into manufacturing, but this technology is revolutionary and extremely promising. So, what is the next portable power 20-year discovery? The well known computer scientist Alan Kay believes: "The best way to predict the future is to invent it."

*Dr. Kerry Lanza is strategic marketing manager at Palladium Energy. Palladium has expertise in lithium-based technologies for battery packs that power portable and backup applications across various verticals including medical, data capture, data storage and consumer electronics.*

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Battery Assembly Equipment continued



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EC-LAB Instruments, from Bio-Logic USA, is the standard in electrochemical battery and capacitor research. These products include modular single and multi-channel potentiostats/galvanostats, high current boosters, electronic loads; powerful applications software; and a full line of electrochemical accessories. The VMP3 multi-channel potentiostat system is the perfect choice for accurate and flexible testing.

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**Chargers**



Cadex designs and manufactures advanced battery chargers, battery analyzers and rapid testers, and battery management software. Our award-winning products are built with one goal in mind — to solve battery problems. Cadex products are the preferred choice for industry leaders in wireless communications, emergency services, mobile computing, avionics, biomedical, automotive and defense applications. Latest innovations include the hand-held, CA-12 featuring Spectro technology capable of measuring capacity in 15 seconds for automotive and mobility applications, and laboratory C8000 battery testing system for battery-powered device developers. Cadex is ISO 9001 and ISO13485 certified and our products are sold in over 100 countries.

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# BATTERY POWER 2010

October 19-20 • Dallas, Texas

Battery Power 2010, an international conference and expo highlighting the latest developments and technologies in the battery industry, will be held October 19-20 in Dallas, TX.

This eighth annual event will feature more than 35 presentations on portable, stationary and automotive battery technology, as well as battery manufacturing, materials and research & development. Topics will include new battery designs, emerging technologies, battery materials, power management, charging and testing systems, battery health, as well as the latest market trends affecting the industry.

The conference is designed for OEM design engineers, system engineers, technical and management professionals involved in battery powered products and systems, battery manufacturing, battery technology research and development and power management technology.

#### New to 2010

- Renewable Power/Storage Systems
- Co-located (combined exhibit hall) with other industry-leading conferences: Thermal Management & Technology Symposium, Remote 2010, Antenna Systems 2010, Energy Efficiency Expo and Electrical Manufacturing & Coil Winding Expo.



Battery Power 2010 will be held at the Gaylord Texan. A special room rate of \$179 is offered to Battery Power attendees. Use the code A-EMC10 to get the discounted room rate: [www.gaylordhotels.com](http://www.gaylordhotels.com).

#### Our Commitment to You

Whether this is your first time participating at the Battery Power conferences, or if you have attended in the past, the 2010 event will provide you with the most up-to-date developments and technologies in the battery and power management market.

#### Who Needs to Attend

- OEM design engineers of battery-powered systems
- Developers and integrators of rechargeable battery systems
- System engineers of standby, backup and UPS systems
- System integrators, vendors, distributors
- Manufacturers of batteries and battery packs
- IC and chipset providers
- Manufacturers of charging, monitoring and testing equipment
- System engineers of electric vehicles
- Product managers seeking new applications and opportunities
- Charging and testing system component providers
- Specialized energy materials suppliers
- Battery component providers

#### Register by August 19<sup>th</sup> for Exceptional Single and Team Discounts

Register for as little as \$495 (\$795 after August 19<sup>th</sup>). A full conference pass includes conference sessions, conference proceedings, networking opportunities, cocktail reception and access to the exhibit hall. The exhibit hall is a combined show floor of six industry leading conferences.

Battery Power attendees can upgrade their conference pass to attend sessions/conference proceedings for Thermal Management & Technology Symposium, Remote 2010 and Antenna Systems 2010.

Visit [www.BatteryPowerOnline.com](http://www.BatteryPowerOnline.com) to register.

#### Pre-Conference Workshops

##### Li-Ion Battery Design, presented by Robert Spotnitz, Battery Design LLC

October 18<sup>th</sup>, 9:00 a.m. to 5:00 p.m.

Registration: Before August 18<sup>th</sup>: \$395; after August 18<sup>th</sup>: \$495

This full day course surveys all aspects of Li-Ion battery design ranging from materials and processes, to cells to packs. A thorough overview of the issues involved in life estimation, thermal behavior and abuse tolerance is provided. How to design Li-Ion cells is discussed in detail with an emphasis on comparing different chemistries. The Battery Design Studio software is used to illustrate design techniques for cells and packs.

This course is aimed at managers, engineers and scientists interested in getting a good overview of Li-Ion technology as well as learning how to design Li-Ion cells. No prior knowledge of Li-Ion batteries is assumed.

#### Conference Program

##### The Battery Industry's Role in US Economic Recovery Panel

The battery industry has received millions of stimulus dollars from the US government as part of the Recovery Act. Each panelist has received government funding and will provide an overview of how the money is being used, goals and potential market/industry impacts.

*Chris Wheaton • EnerG2*

*Dr. Paul Cheeseman • Exide Technologies*  
Additional Panelists to be Announced

##### US Battery Manufacturing Update Panel

Several US battery manufacturing plants are scheduled to break ground in the next couple of years. Leading battery companies will discuss their new facilities and capabilities, as well as what types of batteries will be manufactured and how the new plants will impact the North American battery market.

*Ann Marie Sastry • Sakti3*

*John Battaglini • International Battery*  
Additional Panelists to be Announced

##### Battery Projects and Developments in Government Lab Panel

This panel discussion will feature the country's leading government labs actively involved in battery research and development. Hear new projects that they are working on and new technologies that are expected to impact the market.

*Jeff Chamberlain • Argonne National Lab*

*Claus Daniel, Ph.D. • Oak Ridge National Lab*  
Additional Panelists to be Announced

##### Battery Power Management: Safety, Charging, Fuel Gauging and Cell Balancing, presented by Jinrong Qian, Texas Instruments

October 18<sup>th</sup>, 1:00 p.m. to 4:00 p.m.

Registration: Before September 17<sup>th</sup>: \$99; after September 17<sup>th</sup>: \$149

This workshop addresses the issues surrounding battery power management for safely charging the battery, smartly monitoring the battery for improving protection and accurately estimating battery remaining capacity, cell balancing from handheld, laptop, power tools, e-Bike, electric vehicle and medical applications.

This workshop is structured to provide in-depth coverage of the topics in battery powered applications, and is intended for the audience from entry level to intermediate experience level in battery management.

##### The Cost of Safety, Designing for Safety and the Changing Li-Ion Battery Pack Regulatory Requirements

The characteristics that make lithium battery packs so desirable to consumers also make them the target for regulation and safety testing. With risks like overheating, thermal runaway, hot gas venting and fire, adherence to safety regulations has to be a top priority. This presentation reviews the cost of safety; discusses the reasons for battery failure; presents ideas for building safety into the battery pack design, selecting cells and cell suppliers and testing for safety; and finally reviews the various country regulations, agency certification needs and testing requirements and any new and pending regulations.

*Dr. Like Xie • Palladium Energy*

*Dr. Kerry Lanza • Palladium Energy*

##### Changing Global Regulatory Requirements for Battery Powered Consumer Electronics

The scope of products that use Li-Ion cells and batteries continues to expand dramatically on a global basis. They offer significant advantages of higher power, greater capacity and lower weight. The standard used for cells marketed in the USA is UL 1642, The Standard for Lithium Batteries. The standard used for cells marketed in Europe, and many other countries, is IEC 62133:2002. However it is rare to find cells which have been evaluated to the IEC standard as the UL standard is more predominant. What are the latest trends in regulatory requirements for battery packs shipped internationally? Learn what steps your company should take for regulatory changes. This presentation is being jointly developed by TÜV SÜD America, Inc. and Energy Assurance, LLC.

*H. Scott Griggs • TÜV SÜD America, Inc.*



**Making the Transition to Li-Ion and Qualifying The Right Cell Technology for Your Large Format Battery Application**

Li-Ion batteries are commonly used in a wide range of applications today. The transition to Li-Ion began long ago for smaller portable applications but now the transition to Li-Ion batteries is occurring in larger applications. This presents a significant challenge for the device designer unfamiliar with Li-Ion technology to be able to optimize performance and safety for their new products. This presentation will report on evaluations on Li-ion and lithium polymer cells with various chemistries and form factors.

*Chris Turner • Nexergy*

**Sodium Metal Halide Batteries for Stationary Applications**

This presentation will provide an overview of GE's new Sodium Metal Halide battery technology. Discover the key performance parameters for stationary applications such as UPS, telecommunications and utilities.

*Ganesh Balasubramanian • General Electric*

**Overcoming Battery Pack Design Issues**

With the advances in battery technology, there is a definite need for a system level approach to pack design in order to meet different form, fit and function topologies and connection schemes. To deliver the proper battery pack for a specific application, four key variables need to be considered: electro-chemistry, mechanical, environmental and electrical design. Addressing these variables results in a pack where individual cells work together effectively and safely to provide much higher performance for a particular application.

*Stephen Christo • Boston-Power*

**The Evolution of Li-Ion Safety Testing Since the Laptop Battery Recalls of 2006**

Since the internal short circuit issues in 2006 that resulted in massive recalls of laptop batteries, the industry as a whole has made great strides in cell safety. Underwriters Laboratories will describe the continuing evolution of Li-Ion safety testing and what it means for manufacturers. UL will offer insights emerging from UL's R&D efforts and a look at the development of UL's new testing procedures, standards and certification programs. In addition, attendees will learn more about regulations that are intended to further the safety of Li-Ion batteries.

*Laurie Florence • Underwriters Laboratories*

**New Advances in Li-Ion Battery Monitoring**

Lithium technology is already a dominate technology for portable devices and is increasingly establishing itself in new applications such as hybrid vehicles. The Li-Ion battery is not one type but an agglomeration of a family of batteries with a rich variety of benefits for particular niches. However, as the chemistry has improved, it is becoming increasingly difficult to properly gauge and monitor this family of batteries. Discover two new unique approaches which may improve fuel gauging.

*Joern Tinnemeyer • Cadex Electronics, Inc.*

**Design Advantages and Comparisons of Large Format Li-Ion Batteries**

Li-Ion technology is now actively being designed and deployed in demanding applications ranging from electric and military vehicles to utility smart grids and energy storage for renewable integration. As the energy requirements and system complexities continue to increase, new large format prismatic cells are quickly being designed and deployed into many new applications. This presentation will highlight the relevant differences between traditional cylindrical cells and new large format prismatic cells.

*John Battaglini • International Battery*

**Upscaling New Battery Technologies from Lab to Fab**

This presentation will describe the development of a Lab2Fab concept for Li-Ion batteries for a new generation of hybrid automotives. An overview on the different types of batteries and an explanation of their operating principles and different technologies will be provided. Then different coating technologies and coating parameters as well as different drying and curing solutions are explained in detail. The presentation will offer a complete overview on a battery fab designed for Li-Ion batteries for the newest generation for hybrid cars.

*Thomas Kolbusch • Coatema Coating Machinery GmbH*

**Nanotechnology Manufacturing Techniques for More Efficient Li-Ion Batteries**

Nanoparticles can deliver the properties that battery manufacturers and OEMs are looking for in the next generation of secondary batteries: high energy density (capacity), high power density and high capacity at a lower total weight. In this session, we will lead attendees through the latest applications of nanotechnology for improved Li-Ion battery production and demonstrate real results from grinding trials of both anode and cathode materials. We will explore dry and wet grinding capabilities and discuss future techniques involving nanostructured materials in the production of batteries.

*John Hill • NETZSCH Fine Particle Technology  
Steve Miranda • NETZSCH-CONDUX*

**Using Lithium Polymer Batteries in Commercial Devices**

Commercial, medical and military equipment manufacturers are recognizing the benefits of Lithium polymer batteries, so these thin and custom shaped cells are now used in large, complex, multi-cell packs. The advantages and limitations of lithium polymer cells relative to metal-cased cylindrical and prismatic Li-Ion cells will be explained. Topics covered include the range of dimensions, current delivery capabilities, cycle life, environmental constraints, packaging considerations and supplier assessments. Finally, we will discuss design considerations that device manufacturers must consider when designing a device that utilizes lithium polymer cells in complex commercial applications.

*Dr. Robin Sarah Tichy • Micro Power Electronics*

**Battery Performance and Plug-In Hybrid Electric Vehicles and Other Electric Vehicle Adoption**

Both initial battery costs and Federal tax credits on battery purchases for Plug-In Hybrid Electric Vehicles are important factors in the cost effectiveness of PHEV/EV relative to conventional vehicles, but battery performance also counts heavily. Discover how battery calendar life and deep discharge cycle life factors into customer PHEV/EV economics and expected adoption trajectory. Although Vehicle to Grid (V2G)/and Vehicle to Building (V2B) applications hold promise, we'll describes some performance and other thresholds that need to be reached before V2G/V2B become cost effective.

*Greg Ayres • Navigant Consulting, Inc.*

**Battery System Integration, Energy Management and Testing**

This presentation looks at the requirements for automotive battery packs, including testing and the battery management system. It will highlight the differences between the requirements for hybrid vehicle, PHEV's and EV's. Using a real battery pack as an example the various steps required to specify, design and test the pack and configure / calibrate the BMS will be described. The focus will be on li-ion based packs, but it will be shown that some "micro" hybrid applications can be well served with lead-acid based solutions.

*Neil Johnson • Ricardo, Inc.*

**A Simple Topology for Solar-Charged Battery Systems**

Solar power chargers are convenient, in that they provide a completely wireless power system. Unfortunately, the stacked efficiency of the various switching converters typically results in a loss of 20 to 30 percent. The only option has been to use larger solar cells to compensate. Learn how when using a converter topology efficiency can be increased, while decreasing both cost and board space. The secret is a unified system that handles maximum power conversion for the solar cells, battery charging and load regulation. This presentation will discuss the topology in depth, including tradeoffs and the role of load regulation.

*Keith Curtis • Microchip Technology, Inc.*

**Analyzing the Role of New Battery Technologies In Hybrid Power Systems with High Penetrations Of Renewable Power**

Batteries play a crucial role in hybrid power systems that utilize a high proportion of wind or photovoltaic power. HOMER Energy has helped design hundreds of hybrid power systems. These systems have varied in size, quality of the renewable resource, penetration of renewable power and load and customer characteristics. It has also been used to analyze a wide variety of battery types, including many flavors of lead-acid, nickel, lithium, zinc, vanadium and competing energy storage technologies, such as flywheels and pumped hydro. This presentation offers an overview of the insights that can be derived from economic optimization of the design and operation of hybrid systems under a very diverse sets of real world conditions.

*Peter Lilienthal, Ph.D. • HOMER Energy, LLC*

**Embedded Energy for Pure Power Solutions**

This presentation details advances in solid state energy storage device design that enables these battery-like devices to be co-packaged with other Integrated Circuits. This new Embedded Energy configuration enables new architectures and applications for System in Package and Lab on Chip devices that will be discussed. Innovative packaging examples will be shown. The concept of Pure Power, where devices are "lifted off the grid" to improve device performance, will be detailed. Chip level grid power management techniques will be discussed.

*Steve Grady • Cymbet Corp.*

**Commercial Applications of Lithium Titanate Batteries for Mass Transit**

Advanced Li-Ion cells are a critical enabling technology for the market-readiness and commercialization of mass transit and heavy-duty hybrid electric vehicle (HEV) applications. Discover innovations in Li-Ion cells (11 Ah and 50 Ah configurations) that replace graphite with a proprietary, high-surface area lithium-titanate oxide based anode material resulting in distinctive performance attributes including fast charge/discharge rates, high round-trip efficiencies, long cycle life, safety and ability to operate under extreme temperatures.

*Terry Copeland, Ph.D. • Altairano*

**Safer Li-Ion Battery Design and Development Using Thermal Analysis and Adiabatic Calorimetry**

Thermal analysis and calorimetry play an important role in the development and understanding of safer, high performance Li-ion batteries. There has been a considerable amount of work to develop new methods, instruments, and software to help battery researchers cope with the ever increasing demand for challenging battery applications. It can also be a challenge for the battery researcher to know what's available, what the benefits are and what the limitations are. The emphasis of this presentation is to provide some guidance and advice so researchers can make more informed choices in getting the right solutions.

*Peter Rabovsky • Netzsch Instruments North America, LLC*

**Deciphering Cell Variations in Battery Manufacturing**

The rechargeable battery market will see significant growth in the near future in sectors of portable devices and power electronics, renewable energy storage, powertrain systems for vehicles and telecom backup power applications. More complex use of battery systems is also expected, where battery system management remains a challenging issue. Several factors dictate a cell's performance as reflected in the cell voltage and capacity, thus creating unique characteristics for a cell in a pack under polarization. Learn how to screen cells in a pack and how such screening can help manage pack behavior.

*Matthieu Dubarry • Hawaii Natural Energy Institute  
Bor Yann Liaw • Hawaii Natural Energy Institute*



**Ready for the Grid: How Battery Storage will Support Renewable Energy and the Smart Grid**

The value of grid storage has been vastly increased in recent years by changes in the electric power enterprise. If the cost of Li-Ion batteries falls to levels below \$500/kWh, it is likely that these batteries will have a bright future in stationary applications. There is still a great deal of work that must be done, however, before battery storage can be considered truly "grid ready." Learn the steps that the industry must take to make grid storage a mainstream technology and how the battery industry can take part in this process.

*Haresh Kamath • Electric Power Research Institute*

**Energy Policy in a Battery Charger World**

Addressing plug load energy use continues to remain a relatively untapped opportunity to save energy and mitigate climate change. While large stationary modern electrical appliances receive their power directly from the utility grid, a growing number of everyday devices require electrical power from batteries in order to achieve greater mobility and convenience. This presentation will discuss the energy efficiency implications for battery charger systems (BCS) with a focus on energy use, testing requirements, and an overview of current BCS policy activity including the Department of Energy's mandatory standards development and EPA/Energy Star's voluntary program revision.

*Jeffrey Swofford • Ecos*

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**Busbar Joining of Dissimilar Anode and Cathode Metals: The Role of Intermetallic Compounds**

High-power battery cells commonly have an aluminum cathode assembly combined with an anode utilizing a variety of steel, copper and nickel electroplating. Metallurgically joining an interconnect or busbar between a series of cells poses a challenge to the pack assembly engineers. Vibration, strength, and corrosion concerns for the pack are especially demanding in the automotive sector, and the metallurgy of joints must be fully understood. The complex weld nuggets and subsequent heat-affected zones created by laser, ultrasonic, and resistance welding are reviewed in this presentation. Clad and electroplated composite materials are evaluated as new alternatives for optimizing metallurgical combinations in weld zones. A comparison of strength and toughness for various weld combinations is presented.

*Joseph Kaiser • Technical Materials, Inc.*

**Datacenter Trends Creates Sweetspot for Entry Of New Materials**

Non-traditional computing environments like containers, pods and cloud computing are changing the demands on power storage. Current options leave too few choices. And the new set of power storage requirements is no longer best filled by lead-acid batteries. This has left a gap, or sweet spot, for the entry of new energy storage materials in the datacenter to address the issues of available space, mobility and environmental conditions. This session begins to define the sweet spot entry point for new battery materials in datacenters, ideal battery types, likely early adopters and long term strategies for new entrants to flourish in the IT industry.

*William Muscato • Dell, Inc.*

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**Advancement of Ultrasonic Metal Weld Tooling For Battery Applications**

Li-Ion batteries are finding increasing application due to their high voltage, high power density and low weight compared to competing battery chemistries. Assembling Li-Ion batteries, however, presents new manufacturing challenges. A collaborative study with Ohio State University was conducted to study the effect of ultrasonic tool designs, weld parameters and the number of foil layers on the weld quality. This presentation will discuss the approach and results of this study.

*Matthew C. Bloss • Edison Welding Institute*

**Li-Ion Myth-Buster**

Many widely held beliefs about Li-Ion batteries and their BMSs may be untrue, or at least not entirely accurate. In this session we will try to poke holes into some of those beliefs: that cell capacity depends on rate of discharge, and decreases with number of cycles; that fewer electrons come out of a cell than you put into it; that balancing protects a battery, allows use of the entire charge in a battery, and compensates for variations in cell resistance and capacity; that top balancing is counterproductive, and balanced batteries die more readily than batteries without a BMS; that Li-Ion cells will be damaged if allowed to go below a certain voltage; that there's no need for a BMS if using a CCCV charger and a motor controller with a low voltage cutoff.

*Davide Andrea • Elithion*

**High Efficiency and High Safety LiFePO4 Battery Charger System For Industrial and Medical Applications**

Li-Ion batteries have been widely adopted and used in portable electronics applications due to its high gravimetric and volumetric energy densities. However, sensitivity to over-charging, its lower thermal run-away temperature, limited charge and discharge rates limit its applications. New emerging LiFePO4 battery chemistry has excellent over charging capability, high thermal runaway temperature, high charging and discharge rates. This presentation addresses the LiFePO4 battery charging and discharging characteristics and its charging requirements. High efficiency standalone synchronous switching buck based LiFePO4 battery charge controller and its system design considerations are presented for optimizing the charge system and improving the safety.

*Jinrong Qian • Texas Instruments, Inc.*

*Jing Ye • Texas Instruments, Inc.*

**High Temperature Li-Ion and Li-Thionyl-Chloride Cells**

Incorporating a power source into an application that operates at high temperature, presents a special design challenge for engineers. When standard batteries are exposed to temperatures above 60°C for lithium-ion and 85°C for lithium thionyl-chloride, they suffer from performance issues as higher self discharge, capacity loss, internal resistance increase and from safety issues. High-temperature batteries (up to 125°C for lithium-ion and to 150°C for lithium thionyl-chloride) are specially engineered for optimum performance at elevated temperatures. This session will explore developments in lithium-ion and lithium thionyl-chloride that allow for safe and reliable battery performance across a wide temperature range.

*Olivier Girard • Saft Group SA*




Chargers continued



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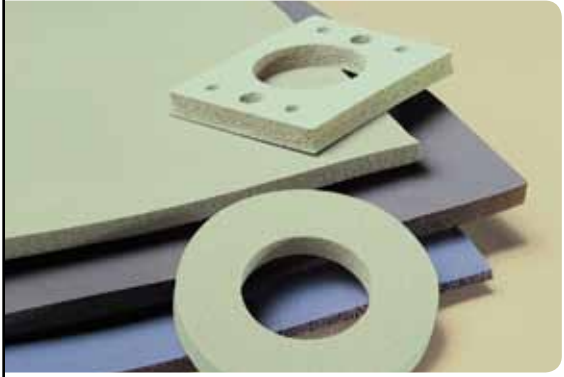
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### September

- 1-3 - SAE International Vehicle Battery Summit, Shanghai, China
- 21-24 - 12<sup>th</sup> European Lead Battery Conference, Istanbul, Turkey
- 29-1 - Batteries 2010, French Riviera

### October

- 12-14 - Advanced Energy Storage 2010, San Diego, Calif.
- 19-20 - Battery Power 2010, Dallas Texas

### November

- 3 - Battery Safety 2010, Boston, Mass.

Send Calendar of Event listings to Shannon Given at [shannong@infowebcom.com](mailto:shannong@infowebcom.com).



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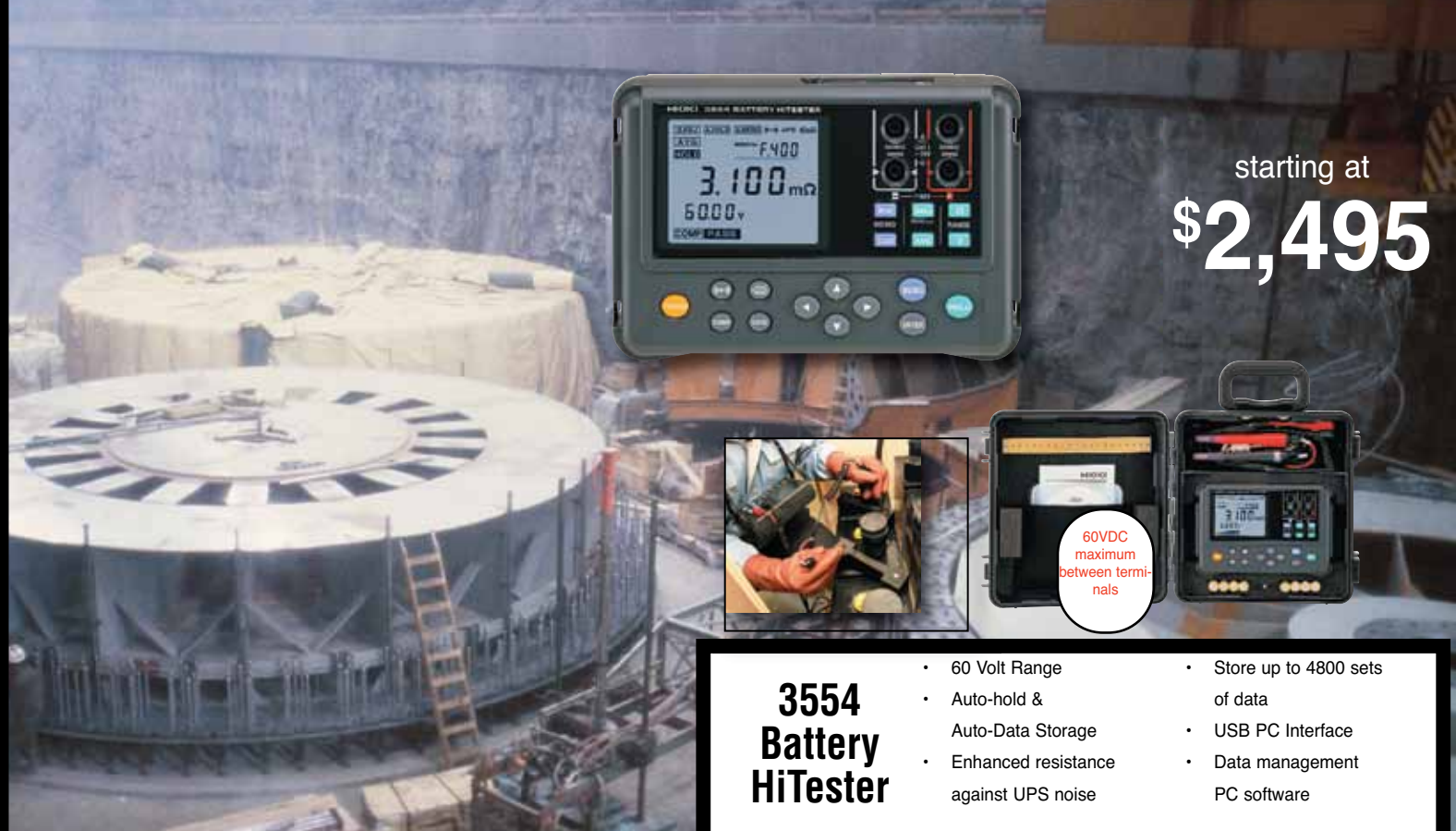
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**Battery Technology Expo** - October 5-7, 2010 - San Jose, CA - **Booth # 3248**

**218th ECS Fall Meeting** - October 18-22, 2010 - Las Vegas, NV

**Battery Power 2010** - October 19-20, 2010 - Dallas, TX - **Booth # 214**

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