OCTOBER 2004

The world's first performance hybrid SUV in the premium segment is the four-wheel drive gas/electric-powered Lexus RX400h. > story

AROUND THE INDUSTRY

Eveready Plans Joint Venture in China

Eveready Industries India Ltd. is looking for a joint venture partner for manufacturing batteries in China and has been in talks with a few companies.

Deepak Khaitan, EIIL's executive vice-chairman and managing director, found during three visits to China that the ability exists to make quality products there.

"We are looking very seriously at China and have already looked at two to three plants," he said. "It will be a joint venture with a private party which already has a facility in China's battery manufacturing area. We will have a minority stake in the proposed venture. I presume that cost of equipment and other infrastructure will be $15 million if we have to set up a plant of that capacity in India."

Lithium-Ion Compounds Contain Less Cobalt

Umicore has successfully developed a new generation of lithium compounds based on nickel, cobalt and manganese to meet the demand from the

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Advanced Battery Technology

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rechargeable battery industry, and specifically from lithium-ion battery manufacturers, for products containing less cobalt.

The new compounds, developed at Umicore's research laboratories in Canada, contain up to three times less cobalt, which is nearly three times its cost of a year ago, but provide an energy density comparable to lithium cobalt dioxide.

Umicore is in the process of deciding on a location for the production of these compounds which will likely be at its plant in Cheonan, South Korea. It is anticipated that initial production will start before the end of 2004 and full-scale production during 2005.

The production and commercialization of these products will add to the choice available to Umicore's customers and has the potential to lower total production cost without compromising on battery performance. It will also mean that metal availability is less of a limiting factor in the use of lithium-ion technology in new applications such as power tools or hybrid vehicles.

Ener1 and Delphi Form Joint Venture

Ener1 Inc. and Delphi Corp. have entered into a non-binding letter of intent to create a joint venture to leverage their combined expertise in lithium batteries. Through the proposed joint venture the two companies look to aggressively pursue business opportunities in the military, automotive, power tool, uninterrupted power supply, medical and personal mobility markets.

"The combination of Ener1's vapor deposition process and its nanotechnology for production of high-rate, low-cost lithium batteries with Delphi-developed high energy capacity technology would allow the venture to have a key advantage in penetrating its target lithium battery markets," says Kevin Fitzgerald, Ener1's chairman and chief executive officer.

It is expected that the new venture would be majority owned and controlled by Fort Lauderdale, Florida-based Ener1 and managed by a team comprised of both Delphi and Ener1 executives. Both parent companies would contribute their lithium battery assets, intellectual property, and technical resources to this venture.

Ultralife Receives $1 Million Order

On August 30, Ultralife Batteries Inc. received a $1 million-plus order from a U.S. distributor for its BA-5390, BA-5372, BA-5367, and BA-5368 high-energy lithium-manganese dioxide military batteries. Delivery was scheduled to be completed in September.

The BA-5390 has 50% more energy and is an alternative to the BA-5590, the most widely used military battery in the U.S. Armed Forces, with more than 50 applications such as the AN/PRC-119 MANPACK single channel ground and

airborne radio system (SINCGARS) and the javelin medium anti-tank missile control launch unit.

The BA-5372 battery is used for memory backup, primarily for the AN/PRC-119 radio. The BA-5367 is used in the AN/PVS-5 night vision goggles, AN/PVS-4 weapon night sight, and various other devices including aiming, messaging and tactical meteorological systems.

The BA-5368 battery is used in the AN/PRC-90 and several other pilot survival radios.

Ultralife's headquarters, principal manufacturing and research facilities are in Newark, New York, near Rochester. Ultralife (UK) Ltd., a second manufacturing and research facility, is located in Abingdon, U.K. Both are ISO-9001 certified.

Amazonas Takes Saft's Li-ion to GEO Service

On August 4, Hispasat launched its Amazonas satellite with batteries using Saft's lithium-ion (Li-ion) modules by a Proton/Breeze M vehicle to continue a revolution in GEO satellite power. Amazonas is the second communications spacecraft launched in the world equipped with a lithium-ion battery. The first was Entelsat W3A, launched on March 15. Both satellites – manufactured by EADS Astrium – are based on the new Eurostar E3000 platform, with Saft's rechargeable Li-ion battery cells.

The Amazonas battery is made up of Saft's Li-ion VES 140 cells and modules. The cells are manufactured at Saft's industrial plant in Bordeaux, France. The battery modules are designed, integrated and tested at Saft's Poitiers, France, facility. The overall battery design, assembly, integration and testing are performed by EADS Astrium at its Toulouse, France, facility.

Saft's Li-ion technology led to a reduction of the overall battery weight in excess of 30% compared to nickel-hydrogen technology. This is a significant factor considering that the satellite flies 22,000 miles above the Earth in its designated orbital slot. By reducing battery weight and space on EADS Astrium's Eurostar E3000 platform, the Li-ion technology enables Hispasat to add more revenue-generating services to the payload.

Hispasat is headquartered in Madrid, Spain, and operates a fleet of satellites covering southwestern Europe and northwestern Africa as well as Central and South America. Saft has previously supplied several nickel-hydrogen batteries for lower-power satellites before embarking on Li-ion for this most recent high-power bird.

Enova Systems Expands Management

Carl D. Perry, previously president and CEO of Enova Systems in Torrance, California, has been promoted to the newly created position of vice chairman of

the board and will assume responsibility for strategic partnerships and governmental relations. Board member Edwin O. Riddell has been appointed president and CEO.

Riddell has been a member of the Enova board of directors since June 1995, and previously was president of CR Transportation Services, an electric vehicle industry consultancy. Earlier he was product manager of electric transportation at the Electric Power Research Institute (EPRI) in Palo Alto, California, and vice president of engineering for the Transportation Group Inc., working on electric public transportation systems. He is a former vice president and general manager of Lift U Inc., maker of wheelchair lifts for the transit industry, and has worked in automotive design and styling for Ford, Chrysler, and General Motors.

Enova Systems develops and produces software, firmware and hardware for the alternative power industry.

Electrolyte for Lithium-Ion Batteries

The Nikkei Weekly reports that Mitsubishi Chemical Corp. will produce electrolytic solutions for rechargeable lithium-ion batteries, becoming the first Japanese company to do so.

The firm's Chinese unit will have the capacity to produce 600 metric tons of electrolytic solution a year, with the output to increase later.

In September, the unit started supplying material to Japanese lithium-ion battery makers operating in China, including Matsushita Battery Industrial Co. and NEC Tokin Corp. These firms have been expanding production against the backdrop of growing demand for cellular phones and personal computers.

Battery electrolyte solution is an organic solvent that enables lithium ions to flow between positive and negative electrodes in charging or discharging. It is infused in the final stages of production.

Saft to Supply Ni-Cad for Train Sets

According to the *Railway Gazette*, Saft is supplying Matrics MRX 130 batteries for the 20 six-car metropolis train sets being built in France and China by Alstom and Nanjing Puzhen Rolling Stock Works for the 16.8km Nanjing Metro Line, due to open in 2006. The contract is for €160 million.

LG Chem to Develop Lithium Battery for HEVs

LG Chem Ltd. of Seoul, Korea, has secured a $4.6 million contract to develop advanced lithium-ion polymer battery cells for hybrid electric vehicles (HEVs) from the United States Advanced Battery Consortium (USABC), reports The

Chosun Ilbo.

USABC was formed in 1991 by DaimlerChrysler Corp., Ford Motor Co. and General Motors Corp. to develop battery cells for next generation eco-friendly vehicles such as HEVs or fuel cell cars.

LG Chem, Korea's largest chemical company, plans to develop highly advanced lithium-ion polymer battery cells by August 2005. Depending on the outcome, it will proceed into the second phase of the project to develop high-tech battery packs for vehicles. The market for large battery cells for HEVs is expected to top 2 trillion won by 2010.

Wireless Power Booster

Zhenqiang Ma, a University of Wisconsin-Madison electrical engineer, has come up with a new arrangement of transistors for the power amplifier, the component that boosts the strength of an electrical signal before sending it to a device's antenna. The new design allows for easier and more uniform heat dissipation. Since excessive heat lowers power amplification, this translates into a stronger signal and less wasted battery power. A cell-phone user could get 25% more talk time out of each battery charge.

Ma has produced silicon chips that use his new design and is now working on versions made from gallium arsenide, the most common semiconductor for cell phones. He says his technology is ready to be licensed by a chip maker and could be on the market by the end of 2004.

Global Makes Power Pack for Army

Global Technologies of Idaho Falls is making a small battery power pack for the Army. The plastic power supply is used during training to replace expensive lithium batteries in the field. It powers the monitors that soldiers use to detect dangerous chemical and biological agents.

Francis Tsang, founder of Global Technologies, says the company invested $250,000 developing and producing the product. Global is one of just 15 United States companies approved by the Army for that kind of work.

Electrovaya Sets Sights on Final Frontier

Electrovaya, Inc., the Mississauga, Ontario-based maker of specialty batteries, received a $2.95 million contract with NASA to make the batteries that power astronaut suits during space walks.

Sankar Das Gupta, Electrovaya's co-founder, chairman, president, and CEO said, "To be powering them is one of the most mission-critical applications you can imagine. We're really humbled they have chosen us."

"My requirements are very similar to the guy running his laptop," says Eric Darcy, lead engineer with NASA's battery group at the Johnson Space Center in Houston, Texas. "He wants long life, long run time and reliability."

Right now, astronauts use batteries made with silver-zinc chemistry to power spacesuits. The technology has been around for 20 years or so and has served NASA well, but a silver-zinc battery generates hydrogen gas that must be vented every so often. This means the battery is not sealed and could pose a danger if it leaks in space.

Electrovaya says its proprietary lithium-ion SuperPolymer rechargeable battery technology has the highest energy density of any commercial battery on the market. The batteries can be found in the Canadian company's Scribbler line of tablet PCs, as well as in its original product, Powerpads, extended-life portable batteries for notebook computers.

Japanese Aim for Tenfold Gain in Capacitor Power

Omron has teamed up with Mitsui, Okamura Laboratory, and Power Systems to develop ECaSS technology that could deliver energy densities of 60Wh/l by 2005, ten times the energy of existing devices.

If Omron can deliver such a density it would allow supercapacitors to eat further into the secondary battery market. NiMH and lithium-ion cells have densities in the order of 100Wh/l.

Unlike batteries, supercaps cannot be overcharged, require no special charging circuits, and can be soldered directly to PCBs. They do not convert energy using a chemical conversion and can be recharged and discharged in seconds.

Also known as electrical double-layer capacitors, supercapacitors are formed from layers of activated carbon and a liquid electrolyte. Positive and negative charges distribute themselves in opposition to each other in boundary layers. Stored charge can be huge, as even a gram of carbon can have a surface area of thousands of square meters due to pores in the carbon.

However, the devices have quite low breakdown voltages, and relatively high (tens of milliOhm) internal resistances means they can only be used in DC circuits.

Omron said activated carbon has reached its practical limit, as no more pores can be made in the material. To take supercapacitors to 60Wh/l, the consortium will use what it calls a "nanogate" capacitor in which ions in the electrolyte form pores in the carbon.

Meanwhile, Maxwell Technologies of San Diego, California, has introduced a D cell-sized supercapacitor rated at 350 Farads and 2.5V. The energy density is

claimed to be 21Joules/cm3, which corresponds to around 6Wh/kg.

Arotech Receives Military Battery Order

Arotech Corp.'s battery and power systems division has received a $650,000 contract for military batteries, an add-on to the February 2004 $2.17 million order from an Asian country.

The unique rechargeable battery powers man-portable electro-optic systems used for military and security applications. The company expects to deliver the additional batteries yet this year.

The division, which includes Electric Fuel and Epsilor Electronics, has also received a contract from a large OEM for the development and delivery of lithium-ion batteries and associated smart chargers to power a military ruggedized tactical computer.

"This first contract in the ruggedized computer market opens new venues for our battery technology," said Robert S. Ehrlich, Arotech chairman and CEO.

Sanyo, GP Set Up Battery Venture

Sanyo Electric Co. and GP Batteries International Ltd. of Singapore have a joint venture in Ningbo to manufacture and market lithium manganese dioxide primary batteries. These are used in both conventional and digital cameras, although the market for the former is contracting.

A Sanyo subsidiary in Tottori Prefecture holds a 51% stake in the $25 million venture, with GP batteries owning the remainder.

Sanyo hopes to expand sales in China by tapping into GP's marketing network.

UQM Appoints Director of Manufacturing

Mark A. Henslee has been appointed by UQM Technologies, Inc. to the newly created position of director of manufacturing.

"We are pleased that Mark has joined our company in this capacity where he will be responsible for manufacturing and process engineering activities, concurrent engineering, and the execution and launch of production products," said UQM Vice President of Operations Ronald Burton.

Henslee's prior experience includes seven years with Globe Motor Co. in a variety of engineering and engineering management positions. He also worked with Prestolite Electric Inc. and Borg-Warner Automotive Control Systems.

For more information, visit www.uqm.com.

Fresno Hopes for Prius Plant

Fresno, California, Mayor Alan Autry says he's optimistic about the city's chance of landing a Toyota plant and nearly 2,000 new jobs with it.

The Prius is a gas-electric hybrid that has gained popularity, especially after the rise in gas prices.

Autry says he and Senator Dianne Feinstein were to meet with Toyota officials in Washington, D.C. "Until now, the Prius has been built only in Japan. But, with demand rising, there are talks about building another plant in the United States."

Right now, customers are waiting an average of six months for the car.

Califonia Hybrid Bill Passes

Gov. Schwarzenegger signed AB 2628 which allows new hybrid electric cars and recent-model low-emission vehicles to use the HOV (high-occupancy vehicle) lanes on California freeways normally reserved for carpools.

The bill opens those lanes to low-emissions vehicles produced during the 2004 model year or earlier as well as new low-emission hybrid-electric vehicles that achieve at least 45 miles per gallon. Meant as an incentive for people to buy hybrids, the bill also limits the total number of HOV stickers for these vehicles to 75,000 and sets procedures to avoid causing the HOV lanes to become congested.

Assemblywoman Fran Pavley, an Agoura Hills Democrat who authored the legislation, said it will encourage "those cars that operate at cleanest efficiency with 80% less emissions than a similar car in a nearby lane." Pavley, who carried a 2002 bill to reduce vehicle "greenhouse gas" emissions starting in 2009, said the idea will also help curb some of the nation's worst smog while spurring U.S. carmakers toward greater fuel efficiency.

Firms Agree on Li-ion Joint Venture

Hitachi Ltd. and Shin-Kobe Electric Machinery Co. have launched a joint venture to develop and produce lithium-ion batteries for use in hybrid vehicles. A new firm will supply the batteries to major automakers in Japan and overseas for use in research and development.

¥1 billion will be invested to install a production line in Hitachi's plant in Hitachinaka, Ibaraki Prefecture.

Sanyo Changes Batteries

Sanyo Electric Co., based in Osaka, Japan, plans to change the design of its rechargeable batteries to use less cobalt. Cobalt prices have more than doubled, rising to US$25 per pound from $9 in September 2003.

World's largest maker of rechargeable batteries used in mobile phones, Sanyo will cut the amount of cobalt in its lithium-ion batteries by changing the composition of some components.

ELECTRIC VEHICLES

World's First Performance Hybrid SUV

Lexus introduces the premium RX400h four-wheel drive sport utility vehicle, calling it the world's first performance hybrid SUV.

Pictured on page 1, the RX400h is powered by Lexus's Hybrid Synergy Drive, a full hybrid system that allows the vehicle to operate in gasoline or electric mode alone or in a combination of both, according to driving conditions. This produces a combination of high performance, quiet, seamless progress, frugal fuel consumption and ultra-low carbon dioxide emissions for its class. The car can accelerate from rest to 62mph in 7.6 seconds, yet in combined cycle driving can match the fuel consumption of a four-cylinder gas engine.

The powertrain comprises a conventional 3.3-litre V6 gas engine with front and rear electric motors, together delivering a maximum power output of 268bhp via a seamless, continuously variable automatic transmission and intelligent electric four-wheel drive.

European sales of the Lexus RX400h will commence in the first half of 2005.

Hyundai Motor Delivers 50 Hybrid Cars

Hyundai Motor will supply 50 units of Click hybrid vehicles to the Korean government in October.

The vehicles will be delivered to the Ministry of Environment for use in environmental protection and traffic control, according to Hyundai.

Hyundai has been making hybrid vehicles designed for testing since 1995, and the Click hybrid is the first commercially available model.

Hyundai plans to put gasoline-electric cars into mass production in early 2006 and will invest 1 trillion won to develop hybrid cars and build facilities.

Bus to Run on Commercial Zinc

Arotech Corp.'s electric vehicle unit is developing technology that allows its zinc-air batteries to use commercially available zinc, eliminating the need for special dendritic zinc. The technological breakthrough will boost commercialization plans for the zinc-air hybrid bus.

Eliminating costly infrastructure will allow transit bus operators to achieve reasonable economies for even small or medium fleets. The new technology will enable small-scale tests, which otherwise would have required a significant investment in zinc regeneration infrastructure. Zinc suppliers and recyclers will be able to supply zinc fuel using existing commercial production technology and capacity – removing a major market entry barrier.

This breakthrough is a result of optimizing the hybrid bus propulsion system during the first three phases of an FTA-funded development and demonstration program. A prototype bus using Electric Fuel's refuelable zinc-air batteries and a hybrid electric drive system attained an inner-city driving range of up to 145 miles on a single charge – enough for a full day of transit service.

As the new technology has been proven in laboratory testing, Electric Fuel plans to conduct field tests of the alternative commercial zinc during an upcoming performance test of the zinc-air all-electrical bus.

GM Hybrids to Enable Cleaner, Quieter Yosemite

The General Services Administration has awarded a contract for 18 new General Motors 40-foot diesel-electric hybrid buses, which are scheduled to go in service in Yosemite National Park in May 2005. Gillig Corp. of Hayward, California, manufactures the buses.

GM hybrid buses are currently in revenue service in Philadelphia and Seattle, which will have more than 230 hybrid buses in service by the end of 2004, the largest hybrid bus order in history. The buses are in "preview programs" in over a dozen major North American cities, including Minneapolis, Portland, and Houston.

"Yosemite National Park is truly one of America's great national treasures," said Elizabeth A. Lowery, GM vice president, environment and energy. "The GM hybrid-powered buses will provide a way for today's visitors to enjoy the splendors of the park while helping to preserve the area for future generations by reducing noise and exhaust emissions."

"Several types of alternative fuel buses were seriously considered," commented Yosemite Superintendent Mike Tollefson. "The decision to pursue diesel-electric hybrids was based on a significant improvement in fuel economy, dramatically reduced emissions, and noticeably quieter operations."

Ford Halts Destruction of Th!nk EVs

Ford Motor Company's U.S. fleet of Norwegian-produced Th!nk electric vehicles may soon fill waiting list orders for the zero-emission cars. The decision marks an abrupt reversal by Ford, which had been ignoring letters of interest from automakers Elbil Norge and Th!nk Nordic and the Norwegian Minister of Transportation.

At the same time, Bill Ford, Jr. wrote a letter to California Governor Arnold Schwarzenegger opposing a proposed law that would encourage purchases of the most fuel-efficient passenger cars. In a letter concerning the Th!nk EV controversy to Norwegian Minister of Transportation Torhild Skogsholm, Ford conceded that, "it is very clear to us that there is a high demand for these vehicles in Norway, not in the least because of the high priority and support your government has given to environmentally friendly transport technology."

Ingvar Sviggum, a vice president of Ford Europe, confirmed, "It is with pleasure that I am able to inform you that we have, with immediate effect, stopped any further scrapping of these vehicles."

Albuquerque to Get Hybrid 'Articulated' Buses

Albuquerque, New Mexico, will receive 12 new 60-foot "articulated" buses in December 2004.

The buses have two sections connected by a sleeve and bend in the middle. The red and gold "Rapid Ride" buses will serve Central Avenue aided by traffic equipment that will give them green lights. The priority signal system will hold a green light for buses or shorten a red signal.

"These are supposed to be mass people movers," Mayor Martin Chavez said at a news conference Tuesday.

Each low-emission, diesel-electric hybrid bus can seat 57 passengers with room for 29 standing passengers and costs about $670,000, 80% of which is being paid by grants from the Federal Transit Administration. The remainder comes from city bond money.

The regular fare will remain $1.

Enova to Build Electric Trains for Singapore

Enova Systems of Torrance, California, has a contract with Tomoe Electric Manufacturing Co. of Japan to develop and produce eight 36-ton battery electric locomotives for Singapore's Land Transport Authority under sub-contraction from Hitachi Plant Engineering and Construction Co. of Singapore. Enova will use components and expertise from Hyundai Heavy Industries of Korea, the

company's hybrid technology development partner. The locomotives will be used as service vehicles for the Singapore Mass Rapid Transit Circle Line system for maintenance, repair, shunting, and recovery of passenger trains. The first are scheduled for delivery in summer 2006.

Enova will supply Tomoe a complete hybrid-electric drive system and technical expertise for integration into the locomotives. Enova is the prime contractor for the heavy-duty drive systems, developing, and producing the advanced battery charger and management systems.

Enova anticipates the total contract to exceed $3 million, the largest production contract for hybrid vehicle components in its history. Enova will also develop a high voltage charging system to enable the locomotive to receive a direct battery charge from the high voltage rail.

PRODUCT NEWS

Cobasys NiMHax® Battery Packs

Cobasys has introduced a line of hydride-based NiMHax battery packs ranging from 144V and 30kW for light duty automotive applications to 672V and 280kW for large commercial applications (trucks and buses). The standard packs are designed to be plug-and-play units and include battery management systems (BMS), thermal management, hardware, software, packaging, and all components necessary to be completely integrated into hybrid vehicle applications.

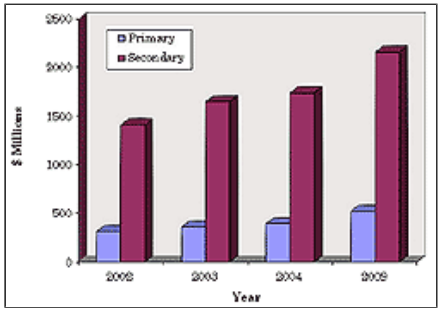
The packs are designed to be liquid cooled which offers packaging and thermal management advantages over air cooling. Liquid cooling also allows mounting in many different locations inside or outside the vehicle since large air ducting is not needed to provide battery cooling. The compact size and low weight of the NiMHax packs offer tremendous power, capacity, packaging, size, weight and life advantages over traditional lead acid packs.

Cobasys is a joint venture between ChevronTexaco and Energy Conversion Devices, Inc.

For more information, visit www.cobasys.com.

Lithium Battery Sales to Reach $2.7 Billion by 2009

According to an updated report from Business Communications Company Inc., *RGB-210N Lithium Batteries: Materials and Markets*, the U.S. lithium battery market is estimated at $2.1 billion in 2004. Rising at an



average annual growth rate (AAGR) of 4.7%, this market will reach $2.7 billion in 2009. The entire U.S. battery market was worth more than $13 billion in 2004.

Primary lithium batteries were worth $365 million in 2003 and the U.S. market should grow to a predicted $522 million in 2009.

Most primary lithium battery types will post steady sales as they retain existing niches but cannot expand into new applications or markets. The most significant exception is lithium-carbon monofluoride, which will experience 10% average annual percent growth, mainly due to increased camera (and to a lesser extent desktop PC and military) sales. Lithium-manganese dioxide cells 7% growth rate is due mainly to increased portable product sales, especially PDAs, and portable entertainment and game systems.

The rechargeable secondary lithium battery market was approximately $1,649 million in 2003 and should grow to more than $2.1 billion by 2009. The portable products market will continue to comprise 85% of the total market with the increase in laptops, cellphones, PDAs, and portable entertainment and game systems. The portable medical products market will post small annual increases in sales over the next five years, but will essentially be flat due to ever lower prices for medical batteries. The stationary market will post very significant 75% AAGR, as UPS and emergency lighting product sales accelerate and as less expensive lithium cells compete with existing lead and nickel-based systems. The military/aerospace market will continue at historic levels, partially because of emphasis on primary lithium cells and partially because of lower prices for lithium-ion cells. The automotive/motive market will post a very significant 57% AAGR as HEVs and niche EVs like scooters begin to switch to lithium-ion.

To order, contact BCC, 25 Van Zant St., Norwalk, CT 06855, phone: (203) 853-4266, email: publisher @bccresearch.com.

Energizer Advances NiMH Rechargeables

Energizer has upgraded its high-capacity AA NiMH rechargeable batteries. The new 2500mAh NiMH AA batteries are suited for high-tech devices, digital and flash cameras, compact disc and MP3 players, and children's toys. They last up to four times longer than ordinary alkaline batteries in digital cameras.

Energizer's 2500mAh NiMH AA batteries will be packed with the new Energizer®

Compact Charger, which is ideal for digital camera cases, small travel bags, and purses. A sliding drawer opens for charging and closes for compact storage. The charger will come with four 2500mAh NiMH AA batteries and will be available in time for the holidays at a suggested retail price of $19.99.

The new Energizer 15-Minute Charger will charge 2-to-4 AA or AAA NiMH batteries at the 15-minute rapid charge rate. Energizer is the first to offer a 15-minute charge time on such high capacity NiMH batteries (up to 2200mAh). The charger will come with four 2200mAh AA Energizer NiMH Rechargeable batteries at a suggested retail price of $29.99.

For more information, visit www.energizer.com

RESEARCH AND DEVELOPMENT

Lithium Cell with No Heavy Metals

NEC claims to have developed a transition-metal-free lithium-ion battery, says Electronics World UK.

Called “organic radical battery,” this is a new type of lithium-ion battery which is attractive as an environmentally friendly, high power, high energy density rechargeable battery.

In the battery, polyradicals are used as an active material in cathodes instead of a transition-metal oxide, usually cobalt or manganese oxides. The polyradical is a nitroxyl polyradical: poly 2,2,6,6-tetramethylpiperidinoxyl-4-yl methacrylate (PTMA).

Both lithium metal and a graphite intercalation compound have been tried as anode active materials with carbonate into which lithium salt is dissolved as the electrolyte solution.

“In the charge-discharge curves, there was no obvious voltage plateau. Average voltage was 3.53V for lithium and 3.44V for graphite, slightly lower than those of normal lithium-ion batteries,” said researchers. “The initial specific capacity of the PTMA was 60-100mAh/g.”

Cycle life of the PTMA electrode is claimed to be 92% after 1,000 cycles – so anode material limits the cycle life. A complete prototype cell achieved a discharge of 3.5V and over 1,000 cycles at a capacity of 70Ah/g.

Safer Electrodes for Lithium-Ion Cells

A number of nonvolatile, low-flammability liquid oligomers and polymers based on aliphatic organic carbonate molecular structures have been found to be

suitable to be blended with ethylene carbonate to make electrolytes for lithium-ion electro-chemical cells.

Heretofore, such electrolytes have often been made by blending ethylene carbonate with volatile, flammable organic carbonates. The present non-volatile electrolytes have been found to have adequate conductivity (about 2 mS/cm) for lithium ions and to remain liquid at temperatures down to -5°C. At normal charge and discharge rates, lithium-ion cells containing these nonvolatile electrolytes but otherwise of standard design have been found to operate at current and energy densities comparable to those of cells now in common use. They do not perform well at high charge and discharge rates – an effect probably attributable to electrolyte viscosity. Cells containing the nonvolatile electrolytes have been found to be a basis for the development of safer high-performance lithium-ion cells.

This work was done by Joe Kejha, Novis Smith, and Joel McCloskey of LithChem for Glenn Research Center. For further information, access the free Technical Support Package online at www.techbriefs.com/tsp under the Materials category.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, OH 44135.

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U. S. BATTERY AND FUEL CELL PATENTS

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