Nickel-Zinc: Recharging Battery Performance and OEM Design Opportunities

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Technology is driven by many factors, and the reinvention of existing technology products to new higher levels of performance requires innovations in materials and science. Critical components in the design of portable electronics, batteries, in the eyes of many, have not kept pace with innovations in their electronic counterparts. Is it time for the reinvention of one of electrochemistry's oldest technologies to fulfill the needs of a new power market—one forged by performance, cost and environmental responsibility?

As the expansion of cordless electronic applications has accelerated, multiple battery systems have been introduced in order to fill the gap for portable and standby power sources. Sealed Nickel Cadmium battery systems were first introduced to the market in the 1960s and were later followed by sealed Nickel Metal-Hydride battery systems. Most recently lithium ion battery systems have made their mark. Yet, each of these rechargeable battery technologies offers a less than ideal solution to the power

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needs of the automobile and portable electronics industries.

Despite the promise for a high-rate expansion in the market for electric assisted automobiles, antiquated Lead-acid and Nickel Metal-Hydride batteries currently dominate the industry. The size, weight and capacity constraints of these rechargeable stalwarts have positioned lithium-ion large format batteries as best to serve the next generation of electric and plug-in HEV automobiles. However, although lithium ion has several key advantages, many technological challenges such as safety, reliability, raw material availability and recycling need to be addressed. These challenges hinder the mass availability of lithium-ion batteries in the global automobile and portable electronics markets.

Benefits Comparison of PowerGenix NiZn Battery

Battery Type	Energy Density (Wh/kg) @ 12A	Energy Density (Wh/L)	Continuous Power Density (W/kg)	Price (¢/Wh)	Cycle Life	Internal Resistance (mOhm)	High-Rate Operating Temperature (°C)	Comments
POWERGENIX (NiZn)	60	170	>600	30-50	100-500	<45	-20 to +60	Exceptional performance, no memory, long shelf life
NiCd	40	135	600	35-60	100-800	>5	-30 to +60	Very toxic, memory problems
NiMH	58	135	600	40-60	100-800	>5	0 to 50	Limited temperature performance range, expensive

It may now be time for the emergence of a reinvented battery technology. First introduced by Thomas Edison for use in electric vehicles during the early 20th century, rechargeable Nickel-Zinc (NiZn) battery technology was effective in serving the electric vehicle until the combustion engine emerged as the technology of choice for automobile propulsion. However, with new breakthroughs Nickel-Zinc is showing potential today to become the new cost effective, safe battery solution for high power motor driven and portable electronics devices.

Current battery solutions open door to innovation

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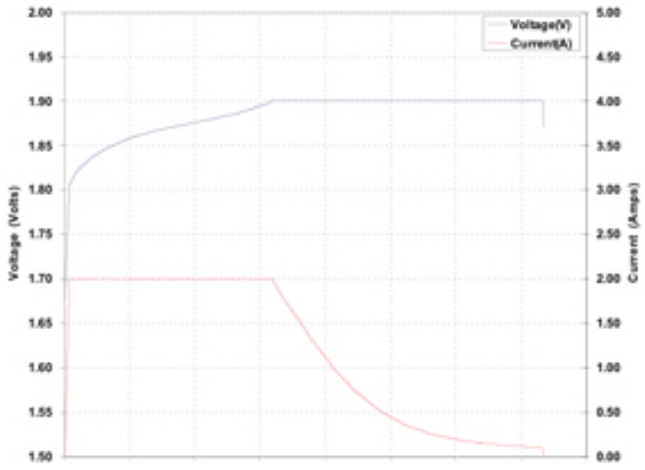
Historically, Nickel-Cadmium (NiCd) and Nickel Metal-Hydride (NiMH) battery power technologies have enjoyed growth in popularity and market share, and served the electronics industry well. However, because open circuit voltage for both of these battery systems is 1.2-volts (V), supporting the existing electronic design requirements typically required four or five cell battery packs. As the marketplace moved forward toward smaller, more portable devices, the number of battery cells became a physical barrier that made it difficult for electronics to reduce size and weight.

As a result of electronic component technologies drive for higher density and smaller, lighter batteries within the last decade, lithium-ion batteries—with a high open circuit voltage of 3.6V—have became a preferred battery technology for many small or weight sensitive electronic applications. The advances in energy density due to its higher cell voltage allowed lithium battery packs with multiple cells to get smaller and lighter. This in turn enabled many portable computing and communication technologies to become a reality, since the battery design was no longer the physical barrier that prevented smaller format electronics design.

Although lithium-ion batteries solved many problems, they also introduced new issues for the industry to address. Chief among the challenges, lithium ion introduced more costly battery systems and concern over consumer safety issues. Because of the volatility of lithium chemistry and electrolyte composition, more elaborate and expensive manufacturing processes are required. Lithium-ion battery packs have also become notorious for product recalls, with misbehaving (exploding) cells and packs even causing personal injury.



The potential dangers of lithium ion have also resulted in the establishment of many new restrictions and regulations for the shipping and personnel use of lithium products on airplanes and other high-risk modes of transportation. To reduce these risks, electronics designers have built in intricate charging and safety circuits, charge meters and other expensive measures to minimize the safety exposures inherent with lithium-based batteries. At the same time, lithium-ion battery manufactures have introduced new designs to improve the safety of the lithium-ion systems. However, while these new designs are less volatile than early lithium batteries, they are also less compelling, due to lower energy densities of the ‘safer’ lithium chemistries and high battery cost.

What’s old is new, reinventing battery performance

Working in parallel with battery technology development, throughout the last decade, smaller silicon device physics has allowed semiconductors to evolve from 5V platforms to 3V platforms. Many new semiconductor designs have driven to even lower voltage platforms—including 1.8V—creating an opportunity to reevaluate optimal battery technology options for many small portable battery applications. In particular, the emergence of Nickel-Zinc, with a high average operating voltage

(1.6V), has presented new design options. A two-cell NiZn battery solution is now compatible with the new generation of 3V semiconductor circuits. This presents designers with an opportunity to eliminate low drop out (LDO) regulators, as there is no longer the need to drop as much battery voltage when using NiZn battery solutions. Since NiZn is packaged in cylindrical cells and offers retail availability, it also allows OEM's an opportunity to design customer-accessed battery compartments.

Many electronic devices that today have exclusively relied on lithium ion batteries, such as cell phones, Blackberries, PDAs and iPhones, may now consider a two-cell NiZn battery solution and improve bill of materials (BOM) cost, eliminate battery safety circuits, meters, chargers, reduce charging heat and allow the consumer to again be responsible for replacement batteries, thus improving device warranty economics. In addition, because Nickel-Zinc battery systems are inherently safer than lithium-ion battery systems, OEM liability issues are minimized.

In general, NiZn battery solutions will not be as light as lithium-ion battery systems, potentially a paramount design consideration for a laptop battery pack designer, but the weight difference between lithium and NiZn battery packs may be indistinguishable to the user for many small portable battery applications. Low profile electronics might also present a need for a flat pack lithium battery, an overriding consideration that justifies a premium priced lithium-ion battery pack; for others, NiZn presents a new exciting technology option to consider.

As electronic connoisseurs continue to demand smaller, more intricate and power-hungry devices, a simultaneous transition to more environmentally friendly electronic design is also

underway. At the request of consumers, and often the requirement of regulatory bodies, new standards for safety, toxicity and recyclability are shaping innovation in electronic design. Nickel-Zinc introduces a solution on all fronts; demonstrating compliance with the new environmental order doesn't need to limit designers on performance or cost. Building on the work of one of our greatest inventors, perhaps it's time for the reinvention of high energy density, high open circuit voltage, eco-friendly, high value Nickel-Zinc batteries.

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