

Cathode Modeling Builds Better Batteries For Power Tools

By David Morrison, Editor, *Power Electronics Technology*

A Li-ion battery technology based on new cathode and additive materials produces batteries with better power performance for high-drain rate applications such as power tools. The technology is being developed by Nanoexa, a nanotechnology-based clean energy company located in south San Francisco, in partnership with Decktron, an LCD and battery manufacturer. Together, Nanoexa and Decktron will offer Li-ion cells in standard formats with improved power performance, greater cycle life and better safety than existing products.

The first batteries will include cylindrical cells in the popular 18650 format. These cells will be optimized for handheld power tools, offering capacities up to 1700 mAh. That compares with 1000-mAh to 1200-mAh capacities for other high-power Li-ion cells currently on the market. The 18650 cells will be available by June 2007, with production quantities available by this December.

The company will also introduce cells with high-power, high-current capability in the 26650 formats. These cells are conservatively rated at 3000 mAh, in contrast with the 2400-mAh capacity of existing cells. The 26650 cells will offer a customizable 20-A to 40-A continuous current rating. Prototypes of these cells will be available by December.

Nanoexa's cells will specify an operating life of greater than 1000 cycles before 20% capacity reduction versus a typical specification of 300 cycles before 20% capacity reduction for existing cells. Safety is also improved as the Nanoexa cells will incorporate a nonflammable additive. Because of this safety additive, the cells are said to be immune to fires and explosions even under adverse conditions.

Nanoexa's batteries are expected to improve performance in real-world applications. For example, one power-saw vendor requires that its product maintain its power through at least 8000 cuts across 2×4 lumber. Under these conditions, Nanoexa projects that its batteries will provide 50% more power density (i.e., greater acceleration and torque) and 50% higher energy density (i.e., longer time between charges) than existing Li-ion cells.

To achieve its high performance, Nanoexa engineered a new cathode material using lithium-nickel-cobalt-manganese-oxide ($\text{Li}_2\text{MnO}_3 \cdot \text{LiMO}_2$, where M is a substitution for NiMnCo) to replace the conventional lithium-cobalt-oxide (LiCoO_2) that has long been used in Li-ion batteries. The Nanoexa cathodes also employ what could be described as a "layered-layered" composite structure. In contrast,

LiCoO_2 employs only a layered structure. When the latter structure loses lithium, it collapses releasing oxygen, which can lead to thermal runaway. That problem is not encountered with the layered-layered structure, so it is said to be inherently safer than LiCoO_2 .

Although Nanoexa isn't the first to experiment with combinations of nickel, manganese and cobalt, the company claims that its success in doing so results from its particular approach to material development. According to Sujet Kumar, Nanoexa's director of technology, his company uses computational modeling to develop its cathode materials. Kumar notes that other battery makers do model the performance of the battery as a complete system, but computational modeling of its electrode materials provides a heretofore-untapped means of optimizing battery performance. Computational modeling also enables rapid prototyping and testing of batteries.

In terms of energy density, Nanoexa says its LiNiCoMnO_2 cathodes produce an energy density of 160 mAh/g. According to the company, the industry-standard energy density for existing high drain cells is 140 mAh/g, but that drops to 120 mAh/g or less in the applications. (In other words, the 140 mAh/g spec is typically specified for low drain applications, so there's a dropoff when the power drain increases. In contrast, Nanoexa claims its 160 mAh/g energy density reflects actual performance at a high C rate.

In addition to sustaining high-power performance, Nanoexa set out to extend battery life with its cell design to meet FreedomCAR performance goals. To do this, the company incorporated an electrolyte additive that prevents cell impedance from growing over time. Normally, the steady growth in cell impedance limits Li-ion battery life to about five years. However, use of the additive is expected to extend battery life to 15 years. This is significant because Nanoexa intends to extend its battery technology to develop Li-ion cells for use in hybrid electric vehicles. The additive also enhances battery safety by preventing thermal runaway.

For more information, e-mail info@nanoexa.com or see www.nanoexa.com.



Nanoexa's Li-ion cells promise improved power and energy density in power tool applications.