Large Lithium Ion (Li-Ion) Batteries

Since their introduction in 1990, Lithium-ion batteries have enjoyed spectacular market growth as the power source of choice for portable consumer products such as cellular telephones, personal digital assistants, video cameras and notebook computers (1). Commercially available 18650 small cells have a specific energy of 180-200 Wh/kg, an energy density of 400-450 Wh/liter and yield 500-1000 full depth charge/discharge cycles. The wide-spread consumer acceptance of these rechargeable lithium batteries can be attributed to their superior performance characteristics, which include higher energy density, longer cycle life, better low temperature performance, lower self-discharge rate and longer shelf life, compared with the traditional Lead-Acid and Nickel-Cadmium rechargeable batteries.

Almost all of the applications of Li-ion batteries are currently filled by small cells, prominently the 18650 size cells having a capacity of ~2Ah, and small batteries constructed by the series/ parallel combination of a few of them. Despite their superiority in practically every aspect of performance of a battery, Li-ion batteries have not penetrated the high-capacity market dominated by Lead-Acid for applications such as backup power systems because of higher cost and safety concerns. Even for applications that are not cost sensitive, potential safety concerns have remained as a deterrent to the widespread use of large Li-ion batteries with hundreds to thousands of watt-hours (Wh) of stored energy. Traditionally such large Li-ion batteries have been constructed from the series/parallel stacking of large monolithic cells, each with tens to hundreds of ampere-hours (Ah) of capacity. Large monolithic Li-ion cells are more prone to safety hazards because they are unable to quickly dissipate the internally generated heat from such abuses such as internal short circuit and overcharge to prevent pressure buildup and the associated cell rupture and venting. Large cells also tend to be more expensive because of higher manufacturing costs.

Small commercial Li-ion cells with a capacity of 1-2 ampere-hours, such as the 18650 cells, have several layers of protection against hazards from short circuit and overcharge, and that account for their widespread consumer acceptance. High volume manufacturing has lowered the price of small Li-ion cells to levels very attractive for high energy applications such as telecom and cable TV backup power. What has been lacking until now is a reliable way to build large batteries from small cells.

Modular Energy Devices, Inc. of Westerly, RI has developed Li-ion battery modules and packs with capacities ranging from 80 to 200 Ah for Cable TV/Telecom power backup applications. The modules are constructed from small, highly reliable and safe 18650 Li-ion cells using the

proprietary electronic technology called Massively Parallel Modular Architecture. The battery modules are readily combined in series and parallel to produce 24, 36 and 48 and 96 V battery packs with appropriate capacities for cable TV/Telecom applications. The use of small cells in combination with the superior electronic architecture makes the batteries safe, reliable and low cost.

There are increased efforts to use large Li-ion batteries for aerospace applications in satellites, military and commercial airplanes, unmanned aerial vehicles and many others. The most famous recent aerospace application of Li-ion batteries is in the Mars Rovers, Spirit and Opportunity, which significantly exceeded the pre-launch life expectations. The 28 V Li-ion batteries performed more than one year on the Martian surface. Large Li-ion batteries are also developed for many other civilian and military applications. In all of these concerns arise about their performance, safety, life and temperature-dependent performance.

Reference:

K. M. Abraham, Stephen Eaves and Farshid Bhaktyari, *"Low Cost Lithium-Ion Batteries for Cable TV/Telecom Power Backup",* in Proceedings of the 2004 Intelec Meeting, Chicago, September 20004