

EnerSys CWB Prismatic Cell Characteristics and Development Strategy

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Abstract

Quallion, a subsidiary of EnerSys Advanced Systems (EAS), has developed a 063450 prismatic lithium-ion cell (6mm^t x 34mm^w x 50mm^h) for conformable wearable battery (CWB) to establish U.S. domestic battery cell supply. EAS's pilot manufacturing line has been set up in Sylmar, California. EAS is trying to establish a domestic supply chain of cell mechanical hardware as well to secure the above cell manufacturing. In this paper, the status of CWB cell development and the characteristics of CWB cells is introduced. Key development items to increase energy density is discussed as well.

Keywords

Lithium-ion cell; Conformable wearable battery; CWB, Prismatic cell; High energy density; Supply chain; Domestic manufacturing

Introduction

Over the past several years Lithium-ion cell technology has been in high demand especially for electric vehicle application lately due to its high weight specific energy density. As a result, lithium-ion cell manufacturing demand has increased significantly with for large-sized prismatic and cylindrical for EV power sources. These cells are being commoditized because of EV market potential volume. In contrast, the production volume ratio of the lithium-ion cells available is relatively small or unique aspect ratio in prismatic shape for each application has become smaller than decades ago. These small volume cells are not getting needed attention to establish supply chain of not only cell by itself but also mechanical components due to cost effectiveness in cell manufacturing. As a result, the small prismatic cell production is localized more in Asia.

EAS has been developing small prismatic cells for US-domestic demands and establishing a cell production line to meet the expected volumes. EAS is also setting up the domestic supply chain for the mechanical components and is one of important key items to support domestic cell manufacturing. Pilot

manufacturing line for 063450 cell (6.0mm^t x 34mm^w x 50mm^h) has been established, and 653450 cell (6.5mm^t x 34mm^w x 50mm^h) is in planning phases to be added as another product line.

1.35 Ah lithium-ion cell in 063450 cell format has been developed. This cell has successfully passed the nail penetration test which is one of the more challenging safety requirements for this cell. EAS has been focused on increasing the energy density of the prismatic cell. The balanced chemistry design is not determined between performances in higher energy density and safety. In this paper, the characteristics of EAS prismatic cell for CWB and the prototyped high energy density cell are introduced.

EAS Prismatic Cell Characteristics

The developed 063450 prismatic cell (Fig. 1) demonstrated 1.35Ah, 3.6V nominal voltage 216Wh/kg). The cell was prototyped domestically in U.S.A. Table 1 summarizes the cell characteristics. This cell is designed with NCA cathode and graphite anode. The cell passed nail penetration test which is one of critical requirements. Fig. 2 shows the typical discharge curve for 063450 cell (1.35Ah).



Fig. 1 Photograph of EAS's 063450 prismatic lithium-ion cell

Table 1 EAS 063450 Cell Characteristics

| | Existing Chemistry (NCA) | Advanced Chemistry (NMC811) |
|-------------------------------|---|---|
| Discharge Capacity (Ah) | 1.35 | 2.3 |
| Cell Weight (g) | 22.5 | 28.5 |
| Weight Energy Density (Wh/kg) | 216 | 303 |
| Abuse Test (Nail Penetration) | Pass | Need Improvement |
| Cell Safety Devices | Safety Valve, (Internal Fuse available) | Safety Valve, (Internal Fuse available) |

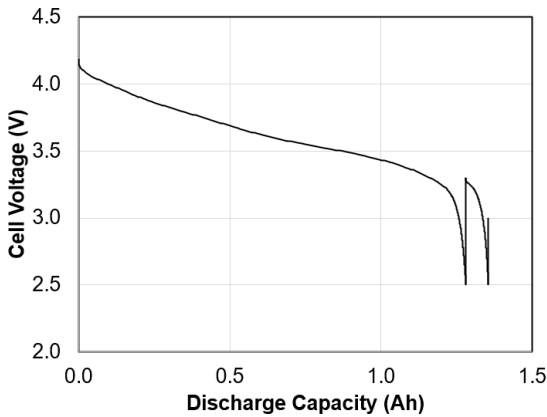


Fig. 2 Discharge curve of 063450 cell with EAS's existing chemistry

Furthermore, 653450 prismatic cell hardware (6.5mm' x 34mm" x 50mm^h) was designed to increase discharge capacity from the existing 063450 prismatic cell (1.35Ah, 216Wh/kg) to 1.75Ah (248Wh/kg) with the reengineered electrode design with NCA / graphite chemistry

EAS has been evaluating the chemistry design to observe the balances between energy density and safety. 063450 cell with NCA cathode and Si-graphite mixed anode has been prototyped to push the energy density to the edge with the current available technology. Fig. 3 shows discharge curve for one of prototype-cell configuration designed with 1.85Ah (255Wh/kg). Fig. 4 shows the discharge curves of NCA/Si-graphite cell at various discharge rate between C/20 ~ 1C at room temperature.

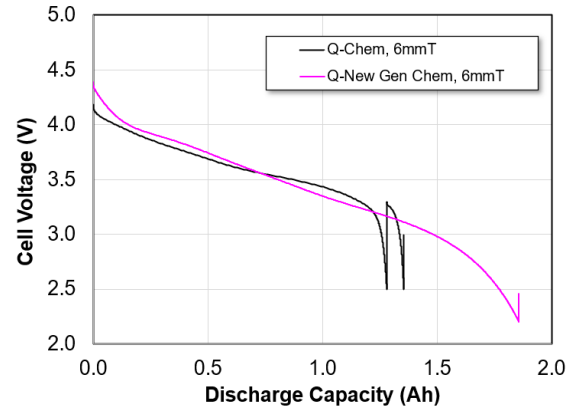


Fig. 3 Discharge curve of 063450 cell with EAS's existing chemistry (NCA/graphite; black line) and new chemistry (NCA/Si-graphite; purple line)

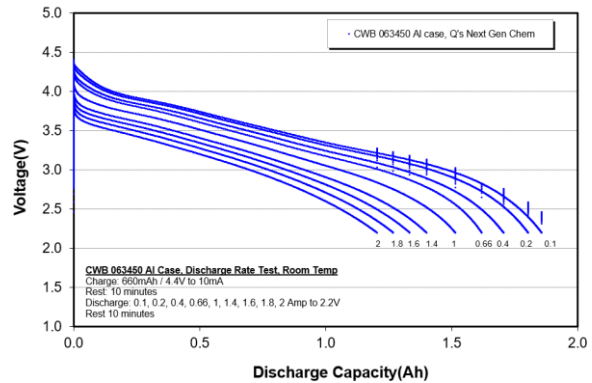


Fig. 4 Discharge curves of 063450 cell at various discharge rate with EAS's new chemistry

The prototype cell demonstrated 2.5Ah, 3.6V nominal voltage (355Wh/kg) shown in Fig. 5 while the safety improvement is still in process. The goal of development is to obtain 653450 prismatic cell with 2.5Ah (350Wh/kg) with passing nail penetration test. The utilized chemistry is NMC cathode and Si anode. Another key development is to suppress cell thickness increase under long term usage of the cell. EAS has developed the advanced electrolyte to help the suppression of swelling. EAS owns and operates the cathode material manufacturing facility for NCA. NMC cathode manufacturing capability can be added to this facility to support material supply chain. This addition helps to establish the vertically integrated manufacturing from electrode active material to CWB prismatic cell.

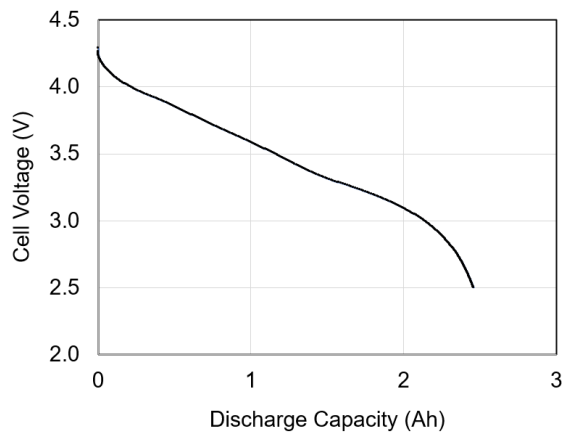


Fig. 5 Discharge curves of 350Wh/kg-class 063450 cell at various discharge rate with EAS's new chemistry

At last, EAS is trying to establish secure supply chain of not only chemicals but also mechanical components such as cell case and cover assembly. EAS has developed plans and designed the manufacturing of critical mechanical components to support these prismatic cell productions in U.S.A.

Summary

EAS has developed lithium-ion 063450 1.35Ah cell for CWB application. The developed cell has passed nail penetration test meeting one of the most challenging safety performance requirements. EAS is trying to increase energy density without losing safety performance. High energy cell up to 2.5Ah, 350Wh/kg were prototyped during the cell development. However, these cells have not met the safety requirements yet. EAS is optimizing the material designs of electrolyte and separator membrane to pass the safety requirements at higher energy density. In parallel, EAS is planning to set up higher volume production with secure domestic supply chain of materials and components.