Thermal energy balance, internal short and thermal runaway

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Battery reliability and safety are crucial for market acceptance for battery applications. Yet, these two important issues are difficult to manage, due to the lack of quantification methods to address them. Here we attempted to define the problem and search for better solutions to quantify reliability for battery functionality and performance. By establishing this practice, we are confident that battery reliability issues could be addressed more definitively and clearly for the goal of battery management. Once the reliability quantification was established, the safety issues and criteria for maintaining safety operation of the battery systems could be addressed with proper context.

The problems of internal short and thermal runaway in a battery are two severe safety issues that need better solutions to handle these potential hazards. Current solutions are more or less based on empirical solutions with a two-prong approach: from bottom up, by choosing better materials for cell design; and, from the top down, by using tests to regulate the requirements for prevention and protection. However, as often a battery may age differently in degree due to different duty schedules, user habits, and operating environments, the condition of a battery and its state might not be well defined. Thus, the effectiveness in prevention of internal short and thermal runaway cannot be assessed confidently. To address the severity of internal short and potential for thermal runaway, we began with detailed considerations of thermal balance in a cell. We believe that understanding and controlling the heat generation in a cell is the first step to deal with these safety hazards. The sources of heat, from Joule heating and chemical reactions, should be identifiable and quantifiable before we can design a safer cell for thermal management.

In this presentation, we shall begin with the discussion on how to define the state of a battery system and to quantify battery state in the system [1-3], followed by the subject on how to determine the amount of heat generation from each attributes and model the thermal balance in the battery system according to the cell chemistry [4] and design. At the end, a mechanical hypothesis on how thermal runaway proceeds in a battery cell would be provided for further discussion on how to quantify thermal behavior of a battery in the practice of commercial product development.

References:

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