Influence of aging paths on the thermal runaway features of lithium-ion batteries in accelerating rate calorimetry tests

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Aging is inevitable during the use of lithium-ion batteries. However, the influence of aging paths on the safety of the lithium-ion batteries remains unclear, leaving uncertainties about safe operation throughout their full life cycle. This paper studies the influence of aging paths on the thermal runaway features in lithium-ion batteries using ARC. Characteristic temperatures are defined to quantify the thermal stability of lithium-ion batteries. Two kinds of aging tests are designed, high-temperature storage and low-temperature cycling. The effects of aging on the change in the characteristic temperatures have been investigated, providing a quantified analysis of the evolution of battery safety performance during aging. The thermal stability of the cells after low-temperature cycling is worse than that of the fresh cells and less than that of the cells that are treated by high-temperature exposure. Although the capacity retention rates of the cells aged by high-temperature exposure and low-temperature cycling can be similar, their thermal stabilities are quite different. The consumption of active lithium at the anode surface to generate a new SEI layer will result in a better thermal stability in the cells that are treated by high-temperature exposure. However, if there is lithium deposition on the surface of the anode, the thermal stability of the lithium-ion battery will become worse. The quantitative discussions and conclusions of this paper can provide guidance on evaluating the safety throughout the full life cycle.

Keywords: lithium-ion battery; energy storage; battery safety; thermal runaway; aging

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