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Changes of Degradation Mechanisms of $LiFePO_4$/Graphite Batteries Cycled at Different Ambient Temperatures

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Abstract

In this work, the commercial $LiFePO_4$/graphite batteries are cycled under C/3 rate at room temperature (25 °C), 35 °C, 45 °C and 55 °C respectively, and the cycle lifetime is 615 days, 404 days, 159 days and 86 days respectively, which indicates that the capacity fade is strongly dependent upon the ambient temperature. The degradation mechanism of battery capacity is analyzed by the electrochemical and physical characterization. At room temperature, the major reason for the capacity fade of full cells is the irreversible loss of active lithium due to the generation and reformation of SEI film. However, when the ambient temperature exceeds 35 °C, the electrolyte decomposition is greatly enhanced by the elevated temperature which could significantly accelerate and dominate the consumption rate of active lithium. Meanwhile, the elevated temperature has an adverse influence on the performance of $LiFePO_4$ material. In addition, the proportions of effects caused by structure degradation and the surface layer for single electrodes are calculated respectively. Through a series of testing experiments, it is concluded that the degradation mechanism is changed when the test temperature is equal or higher than 45 °C, and the elevated temperature is not a suitable stress factor to accelerate the aging of full cells.

Keywords

Lithium ion battery; Elevated temperature; Degradation mechanism; Active lithium; Electrolyte decomposition