SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies and Concepts (3)

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THERMAL RUNAWAY RISKS OF ENERGY STORAGE DEVICES IN SPACE APPLICATIONS

Abstract

Energy storage devices are very important for space missions, Li-ion cells are used to supply energy to spacecrafts or satellites during the eclipse/night time. These cells possess a high energy density but can cause catastrophic incidents that could end up costly space missions, those incidents are manly related to the overheating or thermal runaway of Li-ion cells, leading to possible fire and explosion as observed by incidents in the electronics and aerospace industries. The thermal analysis of Li-ion secondary cells is very important for ensuring safety and reliability of space missions. The thermal behavior of a Li-ion cell is dominated by the exothermic reactions between its electrolyte and electroactive materials. Thermal runaway occurs when the exothermic reactions go out of control, thus the self-heating rate of the cell increases to the point that it begins to generate more heat than what can be dissipated. Understanding the behavior of Li-ion cells during thermal runaway is critical to evaluate the safety of these energy storage devices under outstanding conditions. In this work we analyze the thermal runaway behavior of 18650 Li-ion cells before and after storage and cycling degradation at high temperatures. The thermal behavior of the cells is analyzed using accelerating rate calorimetry. Non-self-heating, self-heating and thermal runaway regions of the cells as a function of state of charge and temperature are identified and compared among the cells. Li-ion cells were tested inside an accelerating rate calorimeter (ARC) 2000^{TM} to record their thermal behavior under adiabatic conditions. Onset temperatures of self-heating and thermal runaway reactions are identified, and by using these onset points thermal mapping plots are made. We are able to identify non-self-heating, self-heating and thermal runaway regions of degraded and non-degraded Li-ion cells as a function of state of charge. The results shows that degraded Li-ion cells tend to be thermally unstable at low state of charges.