Paper ID: 56577
oral
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialized Technologies, Including Nanotechnology (8)

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THERMAL, MECHANICAL, AND ELECTROCHEMICAL ANALYSIS OF LI-ION BATTERY FOR LOW TEMPERATURE SPACE APPLICATIONS

Abstract

The main challenge that hinders the use of lithium-ion batteries in space applications is its low performance at ultra-low temperatures. Such low performance is due to the low ionic conductivity and freezing of the electrolyte which lead to the loss of battery's capacity. Another challenge is the moisture absorption of the electrodes and polymer electrolyte. In this research, an optimized packaged full-cell battery is being developed considering different optimization processes. The full-cell battery will be coated with a protective layer to decrease the moisture absorption and improve the performance and lifetime of the battery. Furthermore, a protective packaged case is also being designed and fabricated using 3D printing technique to enhance the ionic conductivity and prevent freezing of the electrolyte. In addition, a battery heater is being designed to provide requirement of thermal management for the Li-ion battery that can be operated in low temperature environment. COMSOL Multiphysics software is used to study thermal, mechanical and electrochemical performance of the battery under space environment. Experimental tests will be conducted to investigate the mechanical and electrochemical performance using mechanical characterization and battery test setup. Characterization techniques will be employed to examine the change in the material of the electrodes and the electrolyte. Thermal and radiation tests will be carried out using vacuum thermal chamber to analyze the battery's performance in harsh space environment. Parameters such as weight, lifetime and capacity loss will be taken into consideration.