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Thermo-electrochemical testing and simulation of lithium-ion batteries operating in radiation driven space environments

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Advanced energy storage and power management systems designed through rigorous materials selection, testing and analysis process are essential for ensuring mission longevity and success for space exploration applications. Comprehensive testing of Boston Power Swing 5300 lithium-ion (Li-ion) cells utilized by the National Aeronautics and Space Administration (NASA) to power humanoid robot Robonaut 2 (R2) is conducted to support the development of a test-correlated Thermal Desktop (TD) Systems Improved Numerical Differencing Analyzer (SINDA) (TD-S) model for evaluation of power system thermal performance. The temperature, current, working voltage and open circuit voltage measurements are taken during nominal charge-discharge operations to provide necessary characterization of the Swing 5300 cells for TD-S model correlation. Building from test data, embedded FORTRAN statements directly simulate Ohmic heat generation of the cells during charge-discharge as a function of surrounding temperature, local cell temperature and state of charge. The unique capability gained by using TD-S is demonstrated by simulating R2 battery thermal performance in example orbital environments for hypothetical Extra-Vehicular Activities (EVA) exterior to a small satellite. Results provide necessary demonstration of this TD-S technique for thermo-electrochemical analysis of Li-ion cells operating in space environments.

Biography

William Walker graduated from West Texas A&M University with a BS in Mechanical Engineering and began his career with the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC). He is currently pursuing PhD in Materials Science and Engineering from the University of Houston with a research focused on thermo-electrochemical testing and analysis of lithium-ion batteries designed for space applications. He is the Recipient of a 2015-2016 NASA JSC Academic Fellowship offer to focus on lithium-ion battery thermal runaway and propagation research. His publication center is around the use of Li-ion batteries in thermal radiation driven space environments, the passive thermal design of batteries for spacecraft, thermo-electrochemical test and analysis techniques and the general use of Li-ion batteries in the aerospace industry.

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