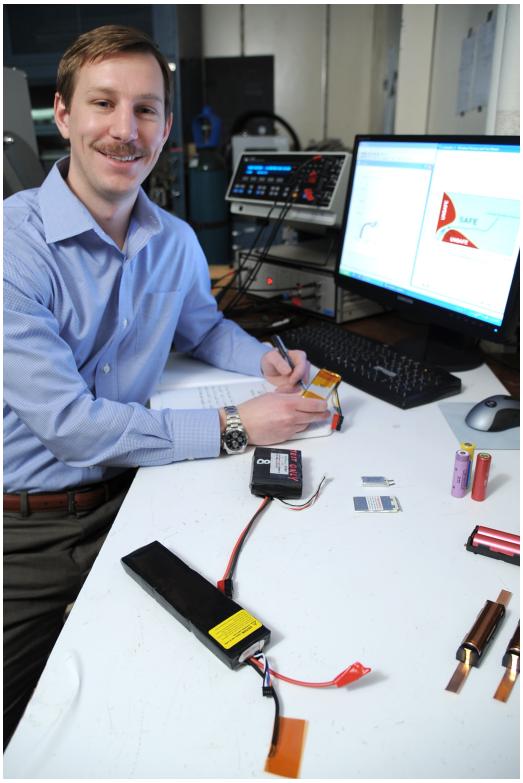
Naval Research Laboratory

The Corporate Laboratory for the Navy and Marine Corps

Lithium-ion Batteries State-of-Health Monitoring



The Naval Research Laboratory (NRL) has developed a diagnostic technique to identify and monitor the state-of-health (SOH) of lithium-ion batteries (LiBs) to improve safety and reduce the safety hazards associated with lithium-ion battery failures. The technique applies a small AC signal (current or voltage) to a battery over a specific frequency range, termed the SOH frequency, which is unique to a battery's chemistry, size and form factor. The impedance response to the perturbation at the SOH frequency is invariant of the battery's state-of-charge and can be applied online to provide real-time SOH monitoring.

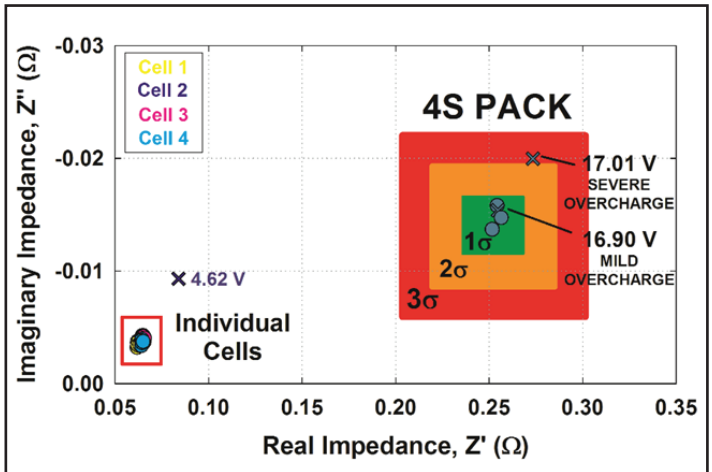
The invention relates generally to battery health monitoring. More particularly, the invention relates to a diagnostic method for monitoring the state-of-health of rechargeable batteries and identifying defective batteries to be taken out of service before causing a serious safety hazard. The method first identifies a single-frequency as which a voltage or current perturbation induces an impedance response which is nearly impendent of the batteries state-of-charge. The impedance response to the perturbation at the single-frequency will be largely invariant when the battery is charged and discharged within the voltage and/or state-of-charge ranges dictated by the battery chemistry. When the impedance response deviates outside of a predetermined safety factor, the method diagnoses the battery cell has been exposed to an abusive condition (overcharge). The impedance circuit and diagnostic can be implemented with basic electronics into a battery management system.

Advantages

Quick data collection and determination of state-of-health; eliminates collection of full impedance spectrum; Can be applied on-line for real-time health monitoring, independent of battery state-of-charge; Diagnostic works at the battery pack level, eliminates the need for individual cell monitoring; Single frequency measurement eliminates the need for complex and expensive electrical waveform generators; Diagnoses fault after a single severe overcharge or repeated mild overcharges.

Opportunities

Monitoring Li-ion battery systems for real-time state-of-health determination; Diagnostic for identifying overcharge abuse in lithium-ion batteries



SOH CHART: IMPEDANCE RESPONSE TO SOH FREQUENCY INDICATING STATE-OF HEALTH OF 4 S LITHIUM-ION BATTERY: **SAFE OR UNSAFE.**

Licensing and Collaboration Opportunities

US Filed Patent Application No. 13/705891 is available for License to companies with commercial interest. Collaborative research and development is available under a Cooperative Research and Development Agreement (CRADA).

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