NREL Highlights RESEARCH & DEVELOPMENT

Internal Short Circuit Device Helps Improve Lithium-Ion Battery Design

NREL's emulation tool helps manufacturers ensure the safety and reliability of electric vehicle batteries.

Battery safety is key to the acceptance and penetration of electrified vehicles into the marketplace. The National Renewable Energy Laboratory (NREL) has developed a device to test one of the most challenging failure mechanisms of lithium-ion (Li-ion) batteries—a battery internal short circuit (ISC).

When battery internal shorts occur, they tend to surface without warning and usually after the cell has been in use for several months. While some failures simply result in the cells getting very hot, in extreme cases cells go into thermal runaway, igniting the device in which they are installed. The most publicized failures involved burning laptop batteries and resulted in millions of recalls.

Many members of the technical community believe that this type of field failure is caused by a latent flaw that results in a short circuit between electrodes during use. As electric car manufacturers turn to Li-ion batteries for higher energy storage capability, solving these safety issues becomes significantly more urgent.

Due to the dormant nature of this flaw, battery manufacturers have found it difficult to precisely identify and study. NREL's device introduces a latent flaw into a battery that may be activated to produce an ISC. NREL uses the ISC device to better understand the failure modes of Li-ion cells and to validate NREL's abuse models.

The device can be placed anywhere within the cell and can be used with both spirally wound and flat-plate cells containing any of the common Li-ion electrochemical systems. Producing a true internal short, the device is small compared to other shorting tools being developed by industry and does not rely on mechanically deforming the battery to activate the short, as do most of the other test methodologies. With the internal short in place, the battery can be used and cycled within normal operating conditions without activating the internal short device. This allows the battery to be aged prior to activation.

The internal short produced by NREL's device is consistent and is being developed as an analysis tool for battery manufacturers and other national laboratories as well as original equipment manufacturers (OEMs). This has broad-reaching applications as automakers bring electrified vehicles to market in larger numbers.

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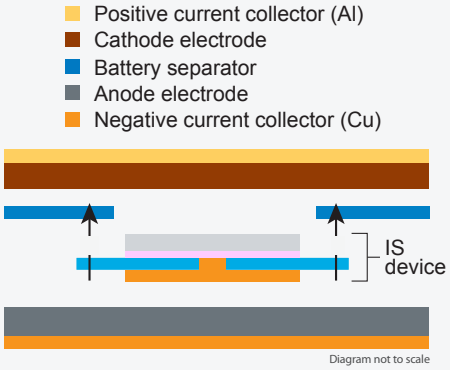

Schematic diagram of NREL's ISC inserted into a battery. Illustration by Stacy Buchanan, NREL

NREL's internal short placed within a pouch cell. Photo by Dirk Long, NREL

Key Research Results

Achievement

NREL's emulation tool triggers internal short circuits to assess and improve Li-ion battery safety.

Key Result

NREL's internal short device can be used to determine how specific changes to battery materials and design will affect safety and evaluate how a battery will react to a latent defect.

Potential Impact

An emulation method was sorely needed to definitively pinpoint the cause of internal short circuits, prevent failures, mitigate their effects, ensure consumer safety—and, ultimately, put more electrified vehicles on the road.

NREL
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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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