

Safety testing of lithium-ion batteries: DC withstand-voltage testing

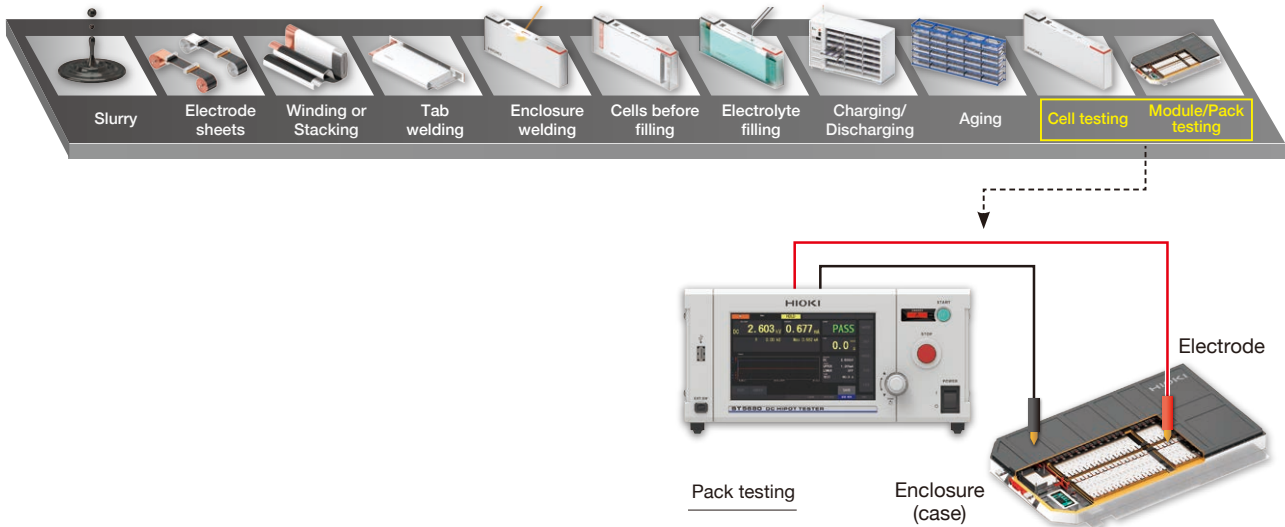
Withstand-voltage testing is performed during the lithium-ion battery production process to verify batteries' insulation strength. These tests are performed as part of shipping inspections in line with testing methods defined by a variety of standards. For lithium-ion batteries, it's typical to use a DC voltage as the test voltage. This Application Note introduces DC withstand-voltage testing performed during module and pack processes.

Targets

Withstand-voltage testing carried out on lithium-ion battery production lines

Testing of the withstand voltage between lithium-ion battery cell, module, and pack electrodes and enclosures

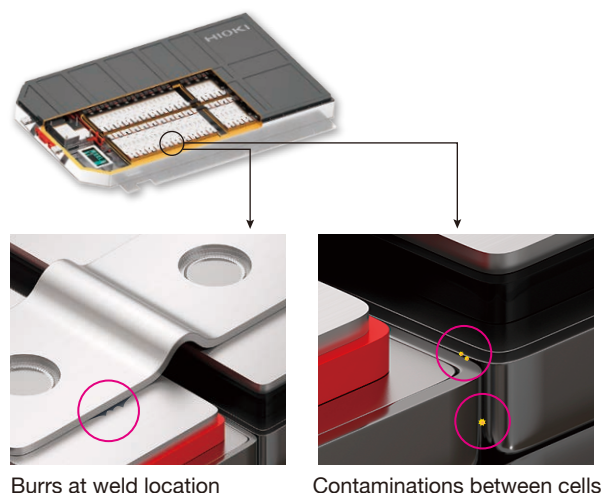
Lithium-ion battery production line processes



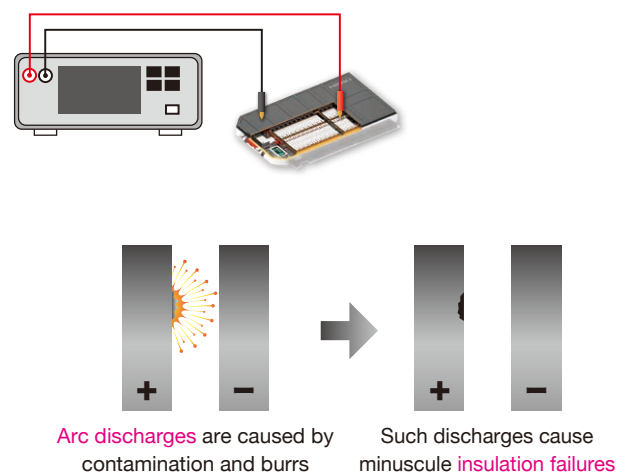
Ensuring detection of arc discharges during withstand-voltage testing

Minuscule contamination can become adhered to battery components when transporting completed cells and during assembly of modules and packs. In addition, burrs may occur at weld locations while performing welding work during assembly. If there is any contamination or burrs in a module or cell when withstand-voltage testing is performed, an arc discharge will occur. At that time, the contamination or burr that caused the discharge will be burn up. As a result, repeating the withstand-voltage test will not detect the defect. However, the locations where a discharge has occurred may suffer minuscule insulation defects. Since such defects reduce the battery's insulation performance, they cause degradation of the battery. In the event they worsen over time, they may cause the battery to overheat or catch fire. The ST5680 provides arc detection function to ensure reliable detection of arc discharge events during withstand-voltage testing.

Burrs and contamination as causes of arc discharges



An arc discharge during withstand-voltage testing



Application Note

Issues

To guarantee battery safety, it's essential to ensure that electrodes (both positive and negative) are adequately insulated from the battery's enclosure, and to prevent abnormal heating, fire, and battery degradation due to defects such as contamination with foreign material and burrs. Batteries' insulation performance is verified by carrying out stringent withstand-voltage testing as part of shipping inspections. To accommodate such testing demands, an instrument that meets the following criteria is requirements is necessary:

- The ability to satisfy test conditions (power supply performance) as defined by international standards
- Fine-grain management of test result data (to improve battery quality reliability, to facilitate investigations into the causes of defects, and to ensure the traceability of test data)

Solution

The DC Hipot Tester ST5680 provides power supply performance that can be used in DC withstand-voltage testing as required by international standards. The instrument is capable of both milliampere-order measurement as well as the measurement of minuscule currents, which is important as the ability to detect microampere-order currents is becoming necessary due to improvements in battery insulation performance. The ST5680's stable, reliable testing capability helps improve the consistency of battery quality.

Output specifications

	DC withstand-voltage testing mode	Insulation resistance testing mode
Output voltage range	0.010 kV to 8.000 kV DC	10 V to 2000 V DC
Maximum rated load	500 W (5 kV/100 mA)	200 W (2000 V/100 mA)
Short-circuit current	200 mA or greater	200 mA or greater
Measurement range	10.00 μA to 100.0 mA	10.00 kΩ to 100.0 GΩ

Waveform and graph display specifications

Display content	Waveform display: Applied voltage/current waveforms during DCW and IR testing Graph display: Voltage measured values, current measured values, insulation resistance measured values
Sampling speed	500 kS/s
Resolution	256 K words
Data storage	Media: USB memory Method: Manually or by acquisition using communication commands
Data formats	BMP, PNG, CSV files

Test 1: Shipping inspection on a production line (standard withstand-voltage testing)

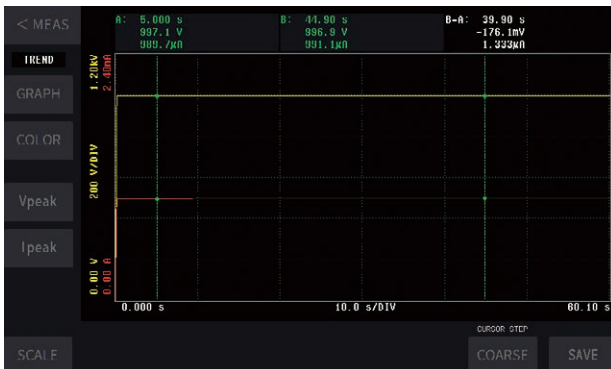
The ST5680 can accurately measure minuscule current values accurately by applying a defined voltage between a battery's electrodes and its enclosure. Test results can be reviewed as values and waveforms. Furthermore, test result data can be managed in more detail. (For more information about test conditions, please review the requirements set forth in the applicable safety standards.)

[Example withstand-voltage test]

Test voltage: 1 kV

Test time: 60 s

Allowable value (judgment criteria): 2 mA



Test results 1



Test results 2

Application Note

Test 2: Testing using the break down voltage (BDV) function

The ST5680 provides a break down voltage (BDV) function for checking the insulation breakdown voltage for test targets. The applied voltage is raised at a specific rate to determine the voltage that causes insulation breakdown. The test method is defined by standards, with variants in which the increasing test voltage is defined in terms of a rate of increase or a step increment. The ST5680 can perform both types of test. This function can be used to evaluate performance (in terms of insulation strength) during battery development.

[Example test with rapidly increasing voltage]

Mode: Rate
Test start voltage: 100 V
Rise rate (voltage increase per second): 100 V
End voltage: 2 kV
Allowable value (detection standard): 2 mA



Test result

[Example test with progressively increasing voltage]

Mode: Step
Test start voltage: 100 V
Rise rate (voltage increase per second): 100 V
Hold time: 1 s
Number of increases: 20
Allowable value (detection standard): 2 mA



Test result

Instrument used

DC HIPOT TESTER	ST5680	HIOKI
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