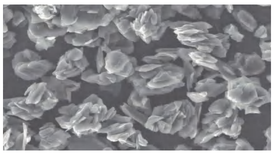
IN-SITU GAS VOLUME ANALYZER

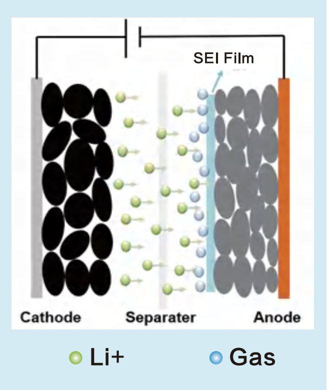
  

—Dedicated to lithium-ion battery testing and development—

GASSING BEHAVIORS OF LITHIUM-ION BATTERY

1) Formation

- The formation process of lithium-ion batteries (LIBs) is accompanied by a large amount of gas production, which is closely related to the chemical system of LIBs, including the anode and cathode materials, electrolyte components, and formation conditions;
- The formation conditions (such as current, cut-off voltage, temperature, pressure, etc.) greatly affect the time and the quality of the formation. Finding an effective method to evaluate the quality of the formation is of great significance for shortening the production cycle, improving the production efficiency and reducing the costs.
- At present, the formation process and conditions basically rely on the empirical judgement, and lack scientific and effective means, which restricts the improvement of the formation technology as well as the in-depth research for the formation process.



2) Overcharge:

- The risk of overcharge is a very important safety issue in actual use of LIBS.
- The overcharge of LIBs is usually accompanied by serious side reactions and produce large amount of gas, which makes the volume or the internal pressure of the LIBs increase rapidly, increasing the risk of thermal runaway;

3) Storage or Long Cycling:

- During the long-term storage or cycling, particularly under high-temperature condition, the sustained side reaction will generate the gas continuously, which is a very critical issue for the reliability of the LIBs.

FUNCTIONS OF IN-SITU GASSING VOLUME ANALYZER

GVM series adopt high accuracy mechanical monitoring system, which can in-situ record.
Cell' volume changes in the whole charge-discharge process, and obtain Cell' accurate gassing volume and gassing rate during each stage.

Efficiency Improvement: Rapidly evaluate the gassing behavior of cells, shorten R&D period, and improve efficicency;

Cost Down: Help optimize formation process, improve production efficiency and decrease enterprise' s production cost;

Cell Design Optimization: Quantify the gassing volume and gassing rate during the whole formation process.
By combinning with the three-electrode analysis of formation curve, the systemic evaluation on the influence of different design factors on the formation quality. Can be implemented which can help to optimize the performance of the LIBs by regulating and controlling the forming quality of SEI.

Reliability& Safety Design: The GVM series can also be used to study and analyze the gassing behaviors during the abuse tests, such as overcharge, high-temperature cycling and so on.

Traditional test method

Ex-Situ Volume Measurement:

The method of displacement volume has been widely used to measure the volume change of LIBs. It is easy to operate but only provide limited information:

- **Single Point Measuring:** unable to acquire the volume charge and gassing rate during the whole formation process;
- **Ex-situ Measurement:** easy to be influenced by the oscillations of the external environment during the transfer process;
- **Weighed by General balance:** unable to achieve an online, long-term, stable, and high-accuracy measurement.
- **High waste of cell:** unable to exclude the influence of cell consistency

Internal Pressure Measurement

The internal Pressure Measurement is another widely used method, which monitor the internal pressure change of cells by implanting a pressure senor device into the cell. This method can be only applied on the hard-shell cells, and need to prepare special cell sample, thus it is complicated on operation with
High cost

Creative solution

In-situ Measurement:

With a self-developed high-accuracy mechanical sensing system installed in GVM, we can implement a continuously long-term&high-stability measurement
for the gassing process of LIBs. By applying an accuracy ADC data acquisition module and combining with multi-functional monitor software MISG, the volume changes during the charging & discharging processes of the LIBs can be recorded in real-time. Moreover, it can realize the multi-channel expansion by exchange the data through the CAN highway.

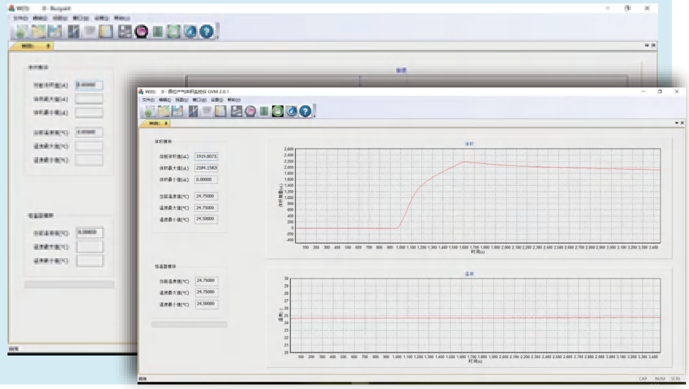
GVM series are the first in–situ gas volume monitors in lithium ion battery industry.

★ Developed with CATL the top power battery company and Authorized exclusively for the patent.

DEVICE CONSTITUTIONAL DIAGRAM AND SOFTWARE

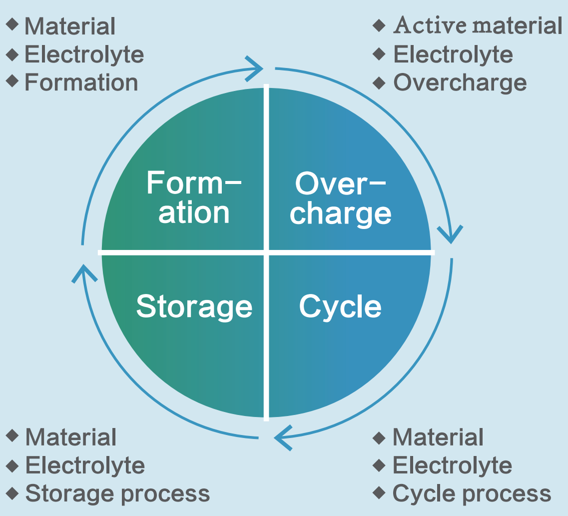
Device constitutional diagram

Software surface



- **High-precision Mechanics Test System:** long-term & in-situ monitoring, and meet the accuracy requirements.
- **Dedicated Test Software:** In-situ collect and display the data measured by the mechanics test system, and automatically draw the volume change curves.
- Auxiliary System: Special structure design, convenient to inset supporting auxiliary system, and realize the temperature adjustment.

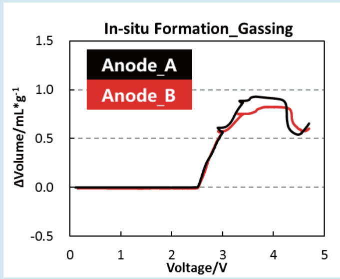
APPLICATIONS



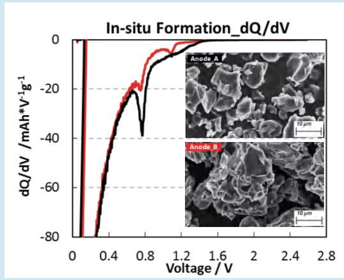
FORMATION–GASSING ANALYZE

1.Gassing analysis for different materials

◆ Test Condition: 25℃ 0.04C/0.1C



Volume change along with the voltage

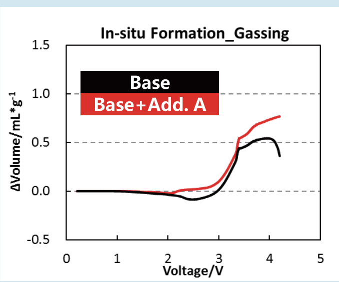


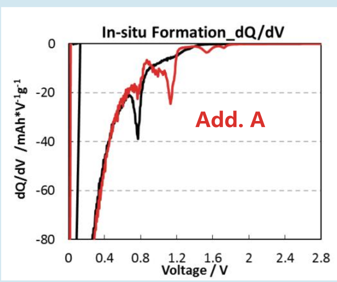
Differential capacity curve of negative potential

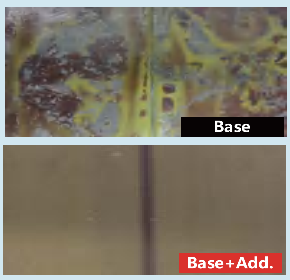
- The modified material A has a smaller particle size than the conventional material B, and the formation of SEI is more sufficient during the formation process, which also causes a larger amount of gas.
- Quickly and intuitively evaluate the effect of the surface modification of the materials by comparing the quantity and rate of the gas production of LIBs made by these materials under the same cell design, which can help the R&D of new materials.

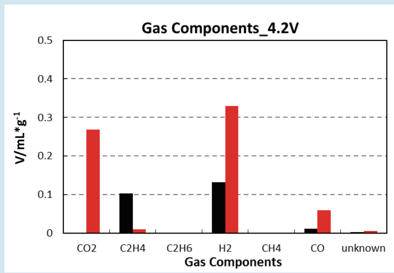
2. Gassing Analysis for Different Electrolytes

Test Condition: 25℃ 0.02C





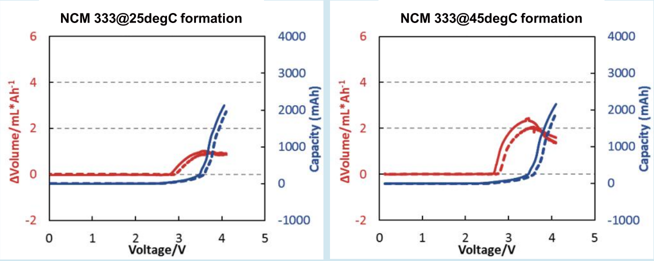




- For the same electrolyte, the amount of the gas generated during the formation of the LIB made by the electrolyte B with a certain additive are larger than the LIB made by the electrolyte A without this additive. Thus this additive can make the SEI forming reaction more complete.
- Quickly evaluate the influence of an additive on the formation process of LIBs by comparing the quantity and rate of the gas production of LIBs made by electrolytes with and without this kind of additive. Combined with the three-electrode method, it can help to improve the electrolyte formulation in a targeted manner.

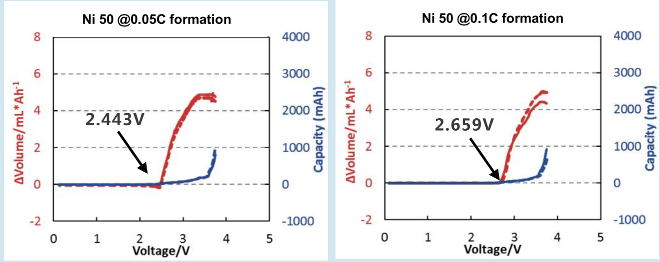
3. Different Formation Conditions – Temperature / Rate

Formation under different temperature



- In the same formation process, SEI forming reaction is more adequate at high temperature of 45degC compared to that of 25degC.

Formation under different charge rate



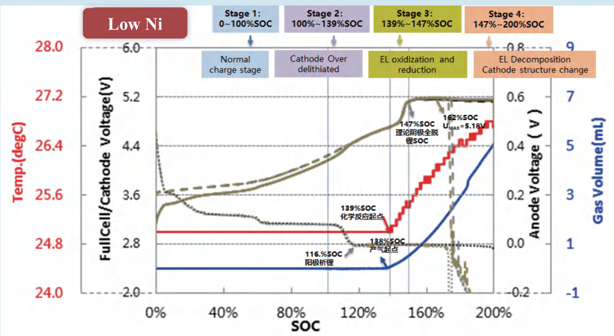
- At the same temperature, with different formation rate, the generation point of the gas is lower in the smaller rate.

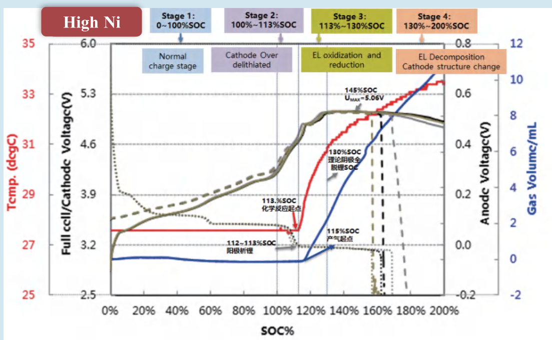
◈ By setting different formation conditions, it can quantitatively obtain the starting voltage of the gas production under different formation conditions, as well as the gassing quantity and the gassing rate of different stage of the formation process, which can help to guide the improvement of the formation process and the technology of LIBs and raise the production efficiency of the enterprise.

▷▷ APPLICATION-OVERCHARGE

1.Gassing Analysis for Different NCM Materials During Overcharging

◆ Test Condition: 25℃ 0.5C





◈ With the increase of the Ni content in NCM materials, it can be found that the starting SOC point of the gas production decreases from 138% to 115%.

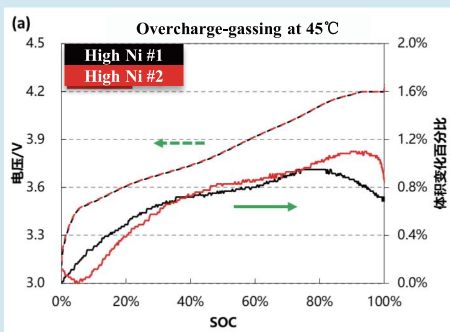
◈ By monitoring the normal charging process of the cells and the volume and temperature changes during the overcharge process, and comparing these data to the three-electrode curves, we can accurately gain the starting voltage and the reaction rate of violent side reactions, which can help us analyze the overcharge performance of the materials quantitatively, and improve the R&D efficiency in a targeted manner.

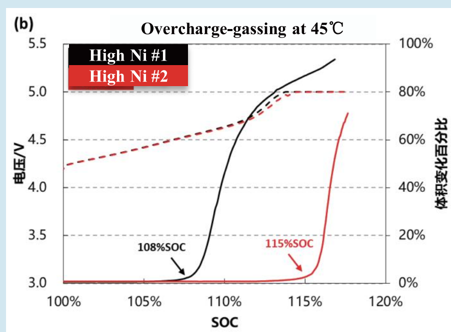
2.Comparing the NCM811 Materials with Different Modified Methods Test Condition: 45℃ 0.5C 3~4.2V~5V

Test Condition: 25℃ 0.5C

◈ In the normal voltage, the volume change of the cell is less than 1.2%, which is basically due to the structural swelling caused by lithium intercalation. When the SOC is larger than 40%, the structural swelling of high Ni-2 is slightly greater than that of high-Ni-1.

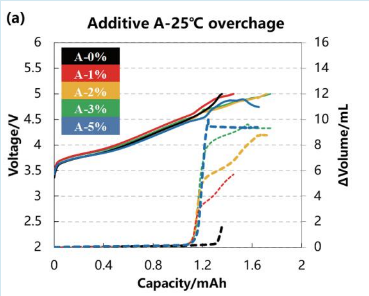
◈ After overcharging to 5V, the starting SOC of gas production of high Ni-2 is larger than that of high Ni-1, indicating that high Ni-2 can adapt to higher voltage range and release more capacity under the prerequisite of keeping the structure stability, which is profit for increasing the energy density of LIBs.

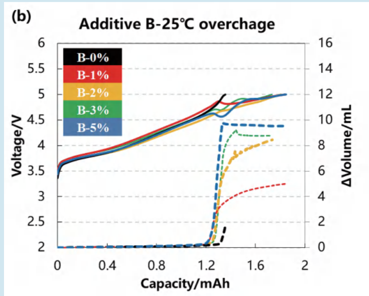


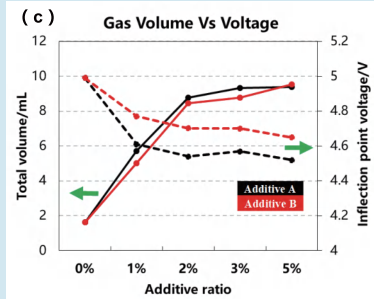


◈ The SOC and voltage corresponding to the starting point of the gas production can be obtained by in-situ continuously monitoring the gas production behavior under the overcharging, which is conductive to develop the next R&D work in a targeted manner.

3.Different Types and Contents of Electrolyte Additives





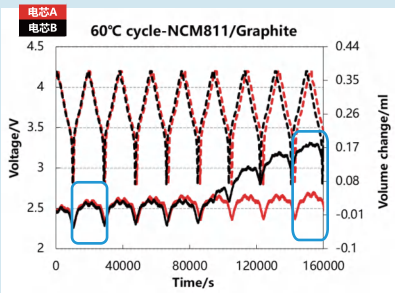


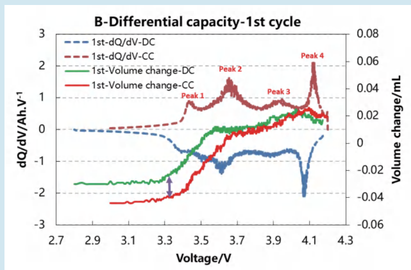
◈ Comparing the gassing behavior of the LIBs under overcharging with different types and contents of the electrolyte additives, it can be found that the reaction potential of additive-A is lower than that of additive-B, which can be a better additive to protect the LIBs under the overcharge condition.

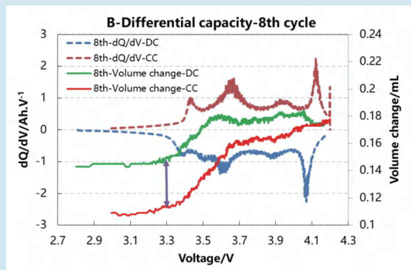
▷▹APPLICATION-CYCLING

1.Different NCM materials

◆ Test Condition: 60℃ 0.5C 3~4.2V







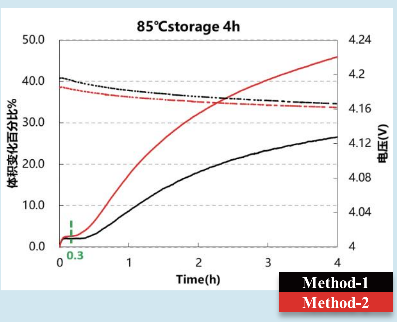
◈ Cell-A and Cell-B are made by different NCM materials. The volume change of Cell-B is larger than that of Cell-A during the long-term cycling, and the irreversible volume change also increase from 0.01 mL to 0.04 mL.

◈ It can help to quantitatively analyze the cycling performance of different materials, modify the materials in a targeted manner, and improve the R&D efficiency.

▷▹APPLICATION-STORAGE

1. Comparing Different Modified Methods

◆ Test Condition: 4.2V full charge at 85℃ for 4H

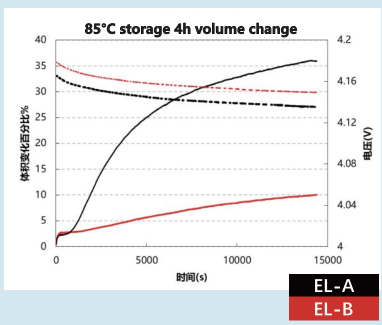


◈ At 85℃, both the voltage drop and the gas production of NCM811 modified by Method-1 are larger than that of NCM811 modified by Method.

◈ It can used to compare the advantages of different modification methods of materials by using this in-situ method to continuously monitor the gas production during storage, which can help to improve the efficiency of R&D.

2. Comparing Different Types of Electrolytes

◆ Test Condition: 4.2V full charge at 85℃ for 4H

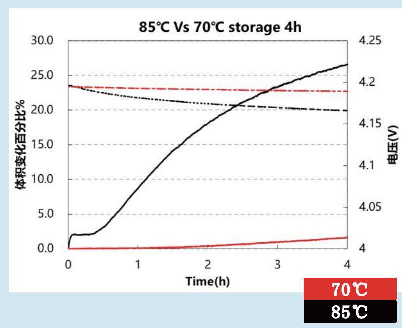


◈ Cell-A and Cell-B are made by different electrolyte systems. From the volume change curves during the full-charge storage, it can be found that Cell-A produce more gas than Cell-B, indicating that the electrolyte of EL-A is much easier to produce the gas under high temperature and high voltage.

◈ Help to quantitatively analyze the gas production performance of different electrolytes, modify the electrolytes in a targeted manner, and improve the R&D efficiency.

3. Comparing Different Storage Temperatures

◆ Test Condition: 4.2V full charge at 85℃ and 70℃ for 4H



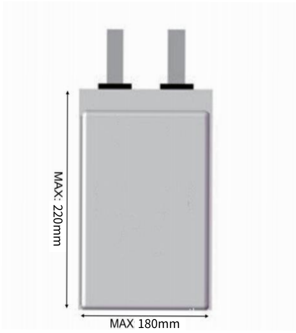
◈ This cell has better storage performance at 70℃, while it produce more gas at 85℃

◈ By using in-situ method to continuously monitor the gas production during, the storage point and maximum point of gas production can be obtained, which is helpful for researchers to carry out the next step of R&D work in a targeted manner.

PARAMETER AND INSTALLATION REQUIREMENT

Parameters and Installation Requirements

Model	GVM2100/GVM2200	GVM2150/GVM2250
Number of channel	Single channel (1 cell) / Dual channel (2 cells)	Single channel (1 cell) / Dual channel (2 cells)
The maximum weight of the pouch cell to be tested	1000g	5000g
Cell test temperature	20~85°C	20~85°C
Volume change resolution	⩽1uL	⩽10uL
Detection Accuracy of Volume Change	⩽10μL	⩽30μL
System stability	⩽10μL(RT25°C、⩽30min), ⩽20μL(RT25°C、30min~12h)	⩽30μL(RT25°C、⩽30min), ⩽50μL(RT25°C、30min~12h)
Maximum size (excluding tabs), as shown on the right: 220*180mm (Customization is acceptable)		



Host installation requirements

	Balance table
Battery immersion liquid	Mineral oil (such as silicone oil)
Power supply	200~240V/50~60Hz
Voltage variation tolerance	± 10%
Power consumption	150W (single channel), 280W (dual channel)
Ambient temperature	25±5°C
Ambient humidity	≤80%RH (no condensation)
Environmental electromagnetic field	Keep away from strong electromagnetic fields
Net weight (dual channel)	55kg (single channel), 60kg (dual channel)
Dimensions (W*D*H)	Dimensions (W*D*H) 500*500*700(mm)

Auxiliary Instrument

Charge and discharge equipment	Self-provided or provided by IEST
Computer	Self-provided or provided by IEST

Note: IEST is committed to continuous improvement of products. IEST reserves the right to alter the specifications of its products without notice.

EN GVM202305

INITIAL ENERGY SCIENCE & TECHNOLOGY (XIAMEN) CO.,LTD
Address: 4th Floor, No. 2, Xinfeng 2nd Road, Huli District, Xiamen City, Fujian Province, China
Tel：(86)592-5367060 Fax：(86)592-5367062
www.iestbattery.com E-mail：info@iesttech.com

IEST WeChat

IEST Linkedin

IEST Major Business

- Special Testing Instruments
- Third Party Detection Service
- R&D solutions