DEDICATED TO LITHIUM-ION BATTERY TESTING AND DEVELOPMENT

IEST

INNOVATIVE LITHIUM ION BATTERY TESTING SOLUTION PROVIDER

PRODUCT CATALOGUE

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IEST 3 Major Business

- Special Testing Instruments
- Third-party Testing Service
- R&D Solutions

IEST Linkedin

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Initial Energy Science&Technology Co.,Ltd

INTRODUCTION

Established in 2018, Initial Energy Science & Technology Co., Ltd. (hereinafter referred to as IEST) is a leading innovator and comprehensive provider of lithium-ion battery testing instruments, integrating research and development, production, and sales. IEST's products have been extensively utilized for the testing and analysis of various lithium battery materials, including powders, slurries, electrodes, and cells (gassing and expansion), among others.

Committed to delivering high-precision lithium-ion battery testing solutions, IEST has supplied over 2,000 instruments to more than 400 lithium battery-related institutions and labs worldwide.

IEST places significant emphasis on the research and development of cutting-edge technologies, and our mission is to enhance our customers' product quality, support their R&D, so as to contribute to the advancement of new energy technologies.

CATALOGUE

Material Characterization

In-situ Gas Generation of Cell

In-situ Swelling of Cell

Electrochemical Characterization

Single Particle Force Properties Test System

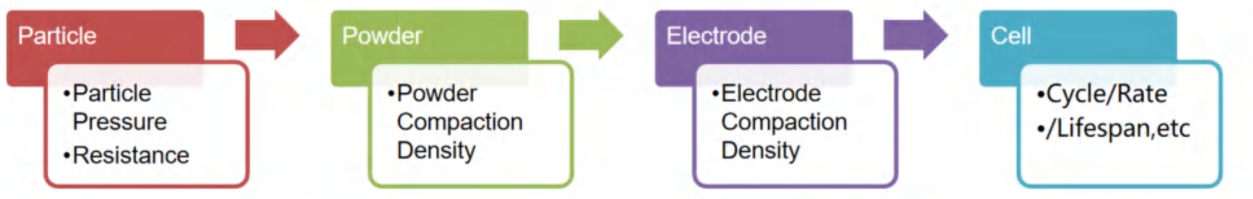
Scan QR code for details

A Model Comparison

Item	Single Particle Force Properties Test System	
Device model	SPFT1000	SPFT2000
Test parameters	Displacement, pressure	
Test range	Displacement：0-80μm；Pressure：0-100mN	
Test Precision	Displacement resolution：1nm；Pressure resolution：0.1mN	
Stress-displacement curve	√	√
Particle image observation	√	√
Automatic displacement platform	/	√
Automatic pressure control	√	√
Fully automatic software	√	√

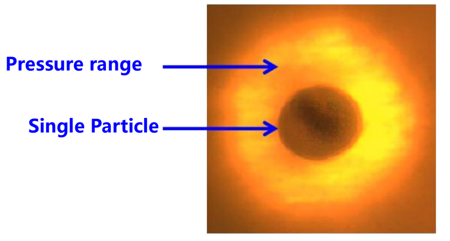
B Product Introduction

Background：Testing the crushing strength of battery material particles can be used to evaluate the pressure resistance of the material and guide the rolling process. Materials with high mechanical strength will have better subsequent cycle stability.

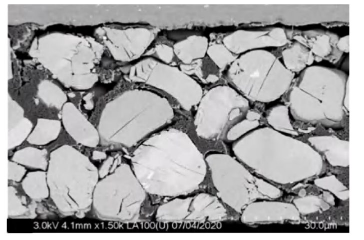


Test Object：Lithium battery anode & cathode materials(cathode: polycrystalline ternary, lithium-rich material; anode : silicon-based, hard carbon, etc.; solid electrolyte)

Test Particle Size：single particle size: 5~50 um

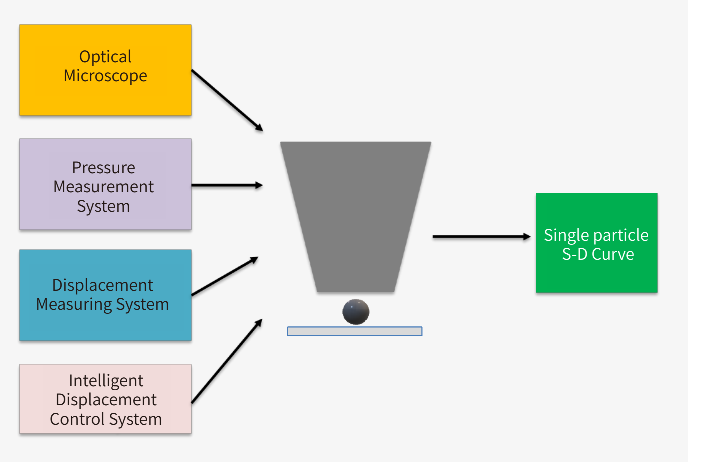


Single Particle Compression (Bottom View)



Particle cracked after cyclic compression (SEM Image)

Equipment Composition



Basic Functions

Apply compression to the particle to generate a force-displacement curve, from which the particle's failure point can be identified. This process determines the force at which the particle is crushed or fails

Functional Modules

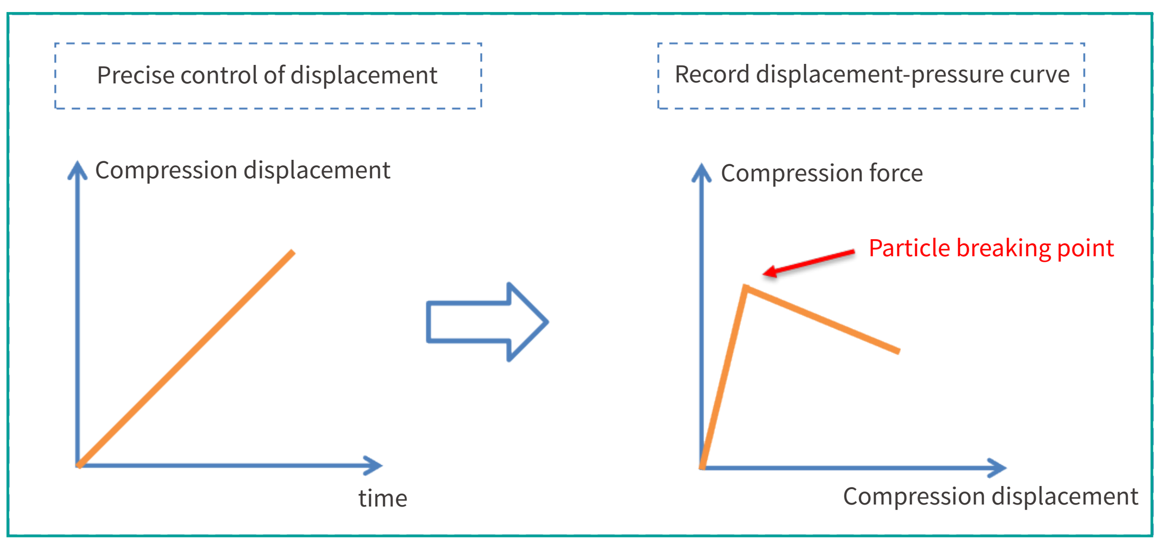
Displacement, pressure, software integrated control;
Real-time photography and video recording of particles.

Structural Functional Dversification	Diverse Testing Modes	Fully Automated Software	Customized for Lithium-ion Batteries	High cost-performance ratio
• High-resolution optical imaging • Displacement precision control • Optical system inverted design • XY automated displace-ment platform	• Displacement control mode • Pressure control mode • Fatigue testing mode	• Real-time display of stress displacement curve • One-click data analysis • Real-time observation and logging. Particle crushing process.	• Cathode material • Anode material • Precursor material • Solid electrolyte materials	• With the same functionalities, the price is much lower than similar instruments abroad.

C Testing Program

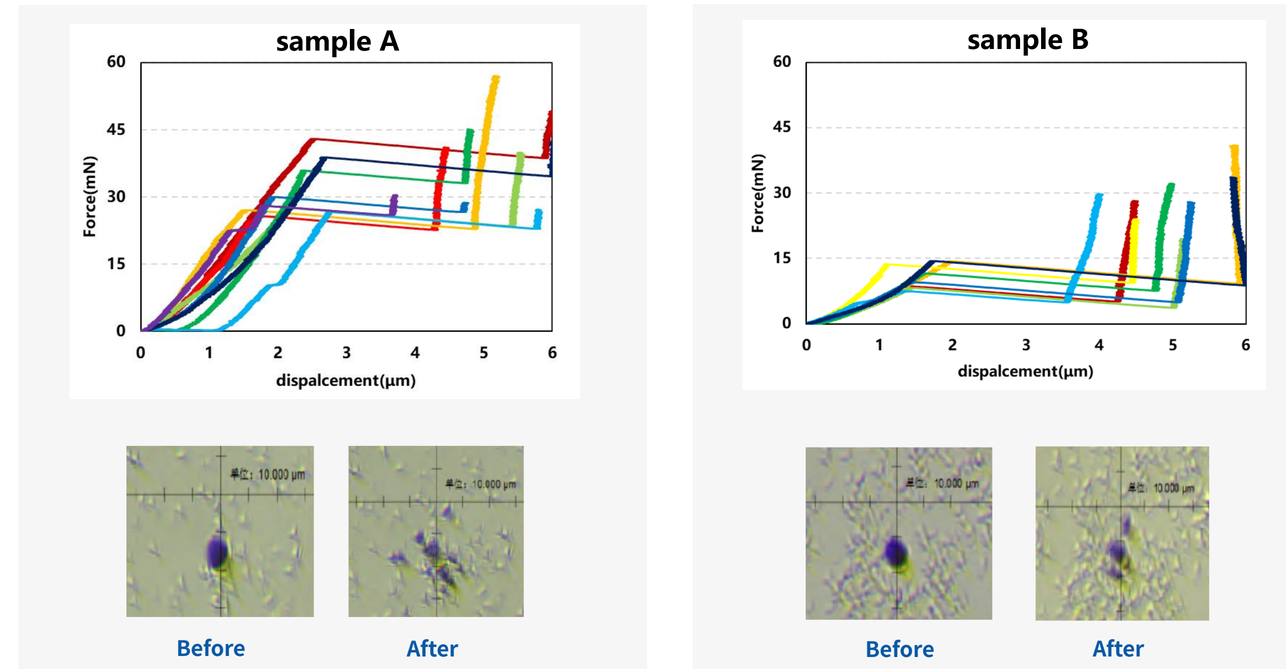
Test Method: Disperse the powder into the liquid. Add it dropwise to the glass slide. Locate the single particle under an optical microscope. Control the pressure head to press down at a constant speed. Collect the force and displacement curves during the particle compression process and calculate the mechanical properties of the single particle.

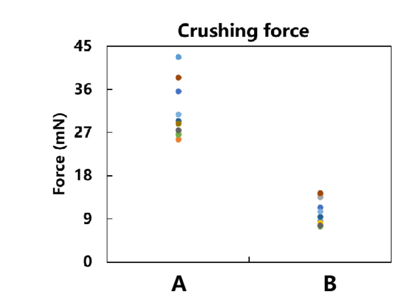
Test Parameters:
Magnification: up to 1200 times;
Pressure test range: 0-100 mN;
Pressure test accuracy: ±0.1 mN;
Minimum displacement unit: 10nm;
Data collection frequency 1000HZ.



D Application Cases

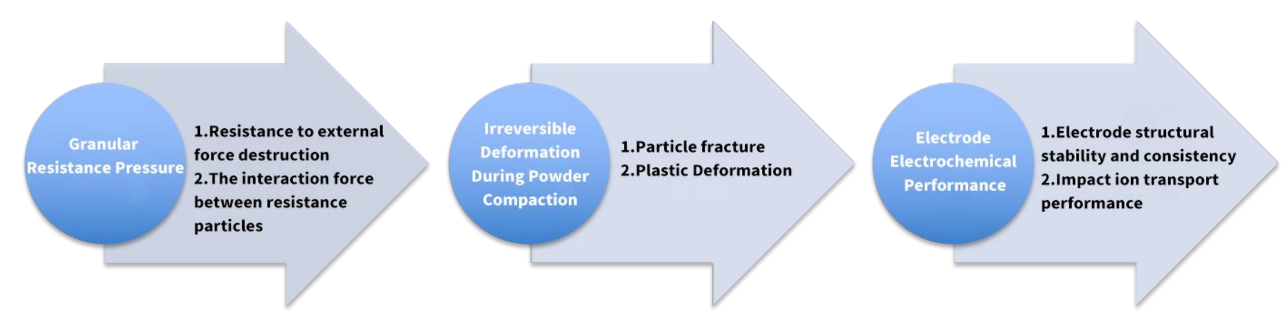
Anode Material——SiC





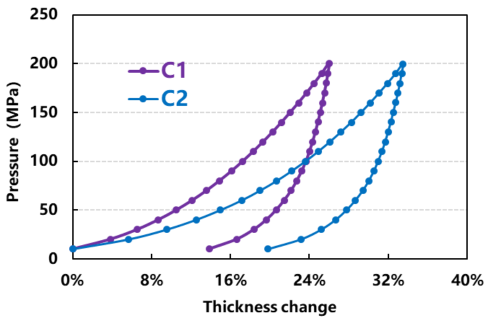
1. Comparison of crushing force distribution: A>B.
2. Analysis of stress-displacement curves: Sample A exhibits initial micro-cracking followed by complete collapse, while sample B experiences direct structural collapse and fragmentation.
3. Comparison of Disintegration States: After fracturing, all three groups disintegrate into fine granular states.

Particle Compression Resistance and Powder Compaction

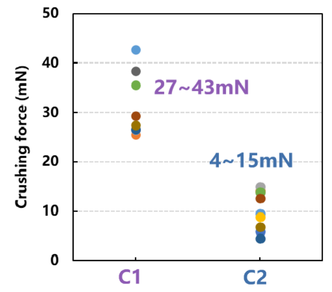


Case 1: 2 Different Pure Carbons

Powder Compression Deformation



Single Particle Crushing Force

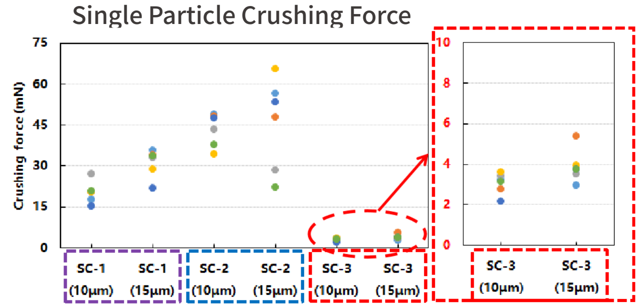


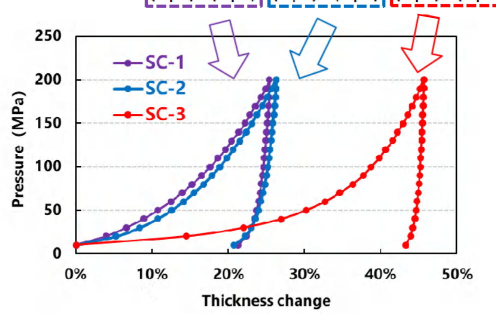
Material	Irreversible Deformation Parameter	Maximum Deformation Value
C1	13.8%	26.0%
C2	19.8%	33.5%

Conclusion: The compressive resistance of particle C1 is stronger. hence, C1 powder shall have a higher compression modulus than that of C2.

Case 2: 3 Different Carbon-Silicon Materials

Single Particle Crushing Force





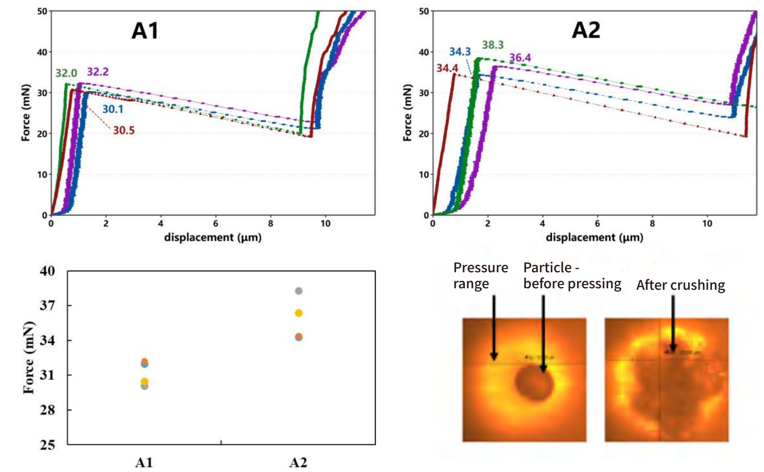
Powder Compression Deformation

Materia	Irreversible Deformation Parameter	Maximum Deformation Value
SC-1	21.3%	25.4%
SC-2	20.8%	26.3%
SC-3	43.3%	45.7%

Conclusion: SC-3 particles exhibit weaker compressive strength, leading to significantly greater maximum and irreversible deformation during compression compared to the other two samples.

Ternary Cathode Material——NCM811

Case 1

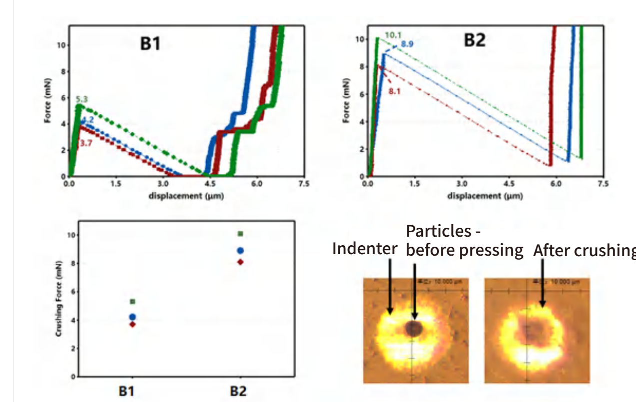


Two ternary materials A1 and A2 are sintered from the same precursor, but the sintering process is different. The particle size D50 is 18 μm.

Conclusion: The compression resistance of A2 is superior to that of A1, and modifying the sintering process can enhance the material's hardness to a certain extent. Single-particle mechanical property characterization methods offer valuable insights for optimizing the sintering process of materials.

Case 2

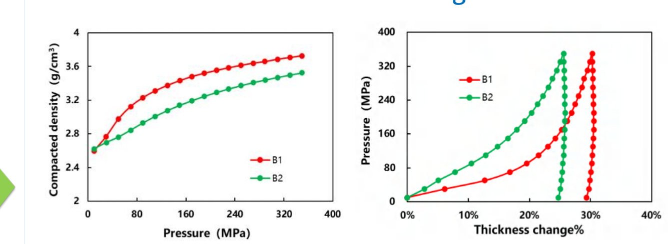
Single Particle Testing



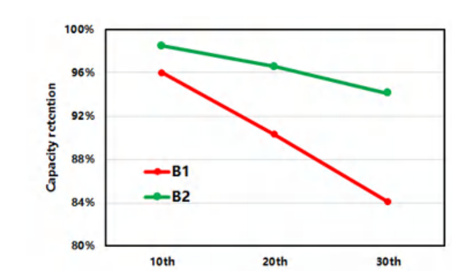
Two ternary materials, B1 and B2, are sintered from different precursors, and the particle size D50 is both 9.5 μm;

Conclusion: The crushing processes of the two types of particles differ, leading to variations in powder compaction density and charging cycle performance.

Powder Testing



Discharge Testing



- After assembling into half-cells following the same procedure, cycling at 3.0~4.3V, 0.5C, and 45, sample B2 exhibits better cycling stability.

Powder Resistivity& Compaction Density Measurement System

Scan QR code
for details

A Specifications of PRCD Series

Model	PRCD1000	PRCD2000	PRCD3000	PRCD1100	PRCD2100	PRCD3100
Test Pressure	1T			5T		
Test Principle	2 probes	4 probes	2 probe & 4 probes	2 probes	4 probes	2 probe & 4 probes
Applicable Samples	High resistance samples	Low resistance samples	Anode & Cathode samples	High resistance samples	Low resistance samples	Anode & Cathode samples (Resistance Range 1μΩ~200MΩ)
Test Condition Range	1.Mold/jig diameter：13mm 2.Pressure：70MPa 3.Resistance range：1μΩ~200MΩ			1.Mold/jig diameter：16mm 2.Pressure：200MPa 3.Resistance range: 1μΩ~1200MΩ	1.Mold/jig diameter：16mm 2.Pressure：200MPa 3.Resistance Range：1μΩ~200MΩ	
Testable Parameters	◆ Pressure relief mode ◆ Powder resistance, resistivity, conductivity, powder thickness, powder compaction density under constant pressure conditions ◆ Powder resistance, resistivity, conductivity, powder thickness, powder compaction density under different pressure conditions ◆ Relationship curve of powder resistance, resistivity, conductivity and powder compaction density					
Mold diameter can be customized						

Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.

B Instrument Principle

Test methods：Put a certain amount of powder (1~2g) into the mold and vibrate it, put the mold into the instrument box, set the pressure (≤200MPa) and the holding time, and start testing the thickness and resistance changes of the powder during the compression process.

Test parameters：Stress, pressure, ambient temperature, ambient humidity, thickness, resistance, resistivity, conductivity, & compacted density.

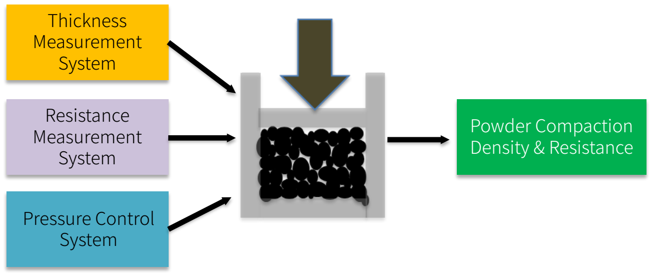
Calculation formula：

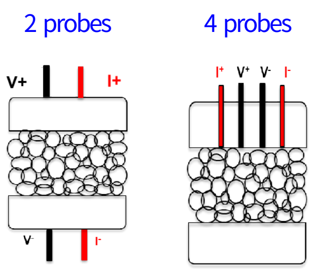
Compaction Density(g/cm³)： $D = \frac{m}{S*L}$

Resistance(Ohm)： $R = \rho\frac{l}{S}$

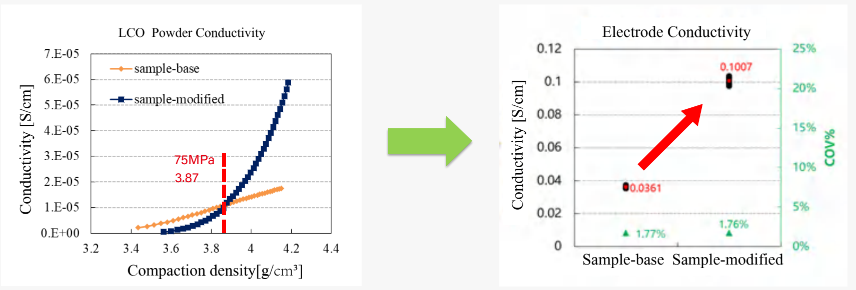
Conductivity (S/m)： $\sigma_e = \frac{1}{\rho} = \frac{l}{RS}$

Resistivity(Ω*cm)-PRCD2100： $\rho = k\frac{U}{I}$ (Where k is the compensation coefficient)





C Why do we recommend high pressure?



LCO Powder

Different pressure is applied to the electrode after rolling, and the compacted density is greater than 4.0g/cm³.

Result analysis：

Result Analysis: Using LCO powder as an example, when the compaction density of the modified powder sample is less than 3.87g/cm³ (pressure <75MPa), its conductivity is lower than that of the unmodified powder sample.

However, when the compaction density exceeds 3.87g/cm³ (pressure >75MPa), the conductivity of the modified powder begins to surpass that of the unmodified powder, and the conductivity improves significantly as the compaction increases.

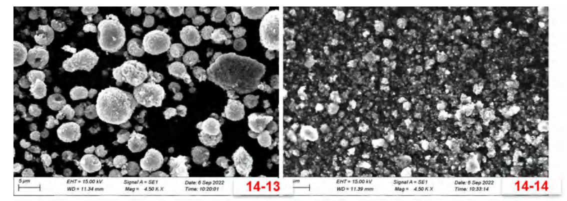
Conclusion: When testing the conductivity of powder, the compaction density should be close to the actual compaction of the powder in the electrode.

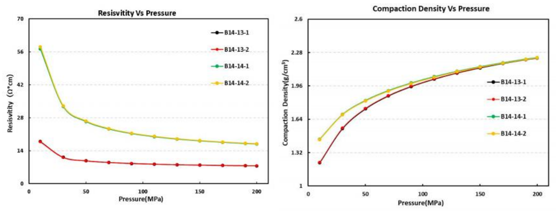
D Application Cases

(1) Cathode material-LMFP

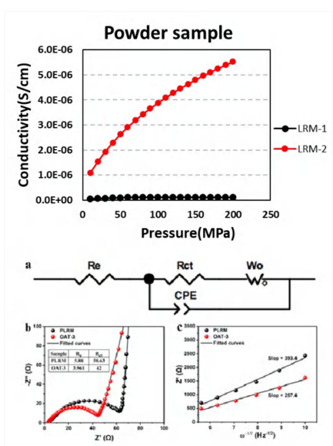
Conclusion 1: The conductivity of B14-13 is superior to that of B14-14. This is primarily due to its lower porosity, which enhances particle contact throughout the compression process, resulting in better conductivity.

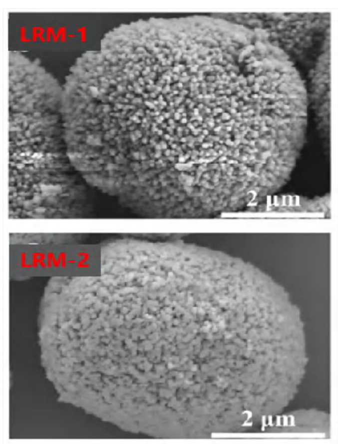
Conclusion 2: The compaction density shows minimal difference under high-pressure conditions but varies under low-pressure conditions. This is mainly because samples with a wide particle size distribution have poor flow and rearrangement characteristics, leading to higher porosity and lower compaction density under low pressure.





(2) Lithium-rich materials

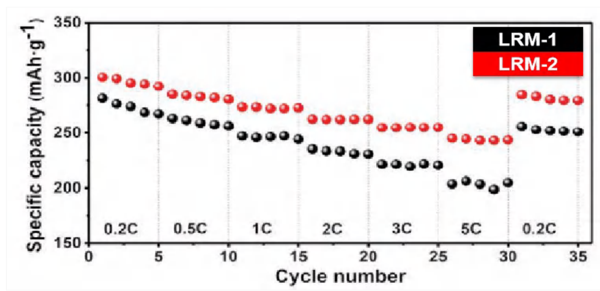




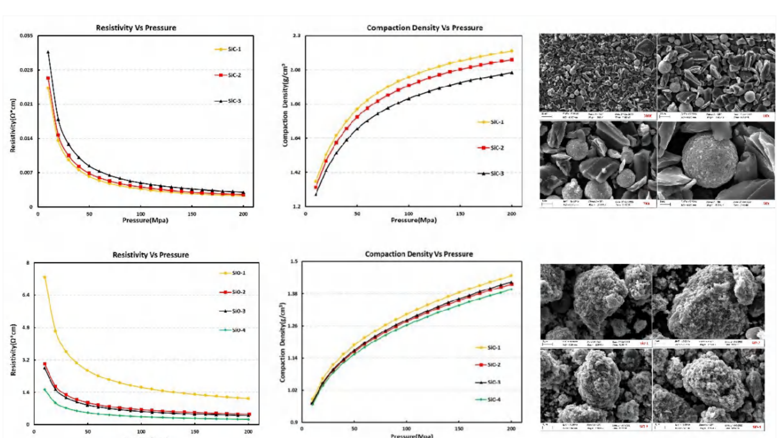
W.B. Guo et.al. Adv. Mater. 2021, 33, 2103173

Analysis of the lithium-rich material with different modification methods

The resistivity of the lithium-rich material can be reduced effectively by adjusting its surface structure.



(3) Silicon-based materials



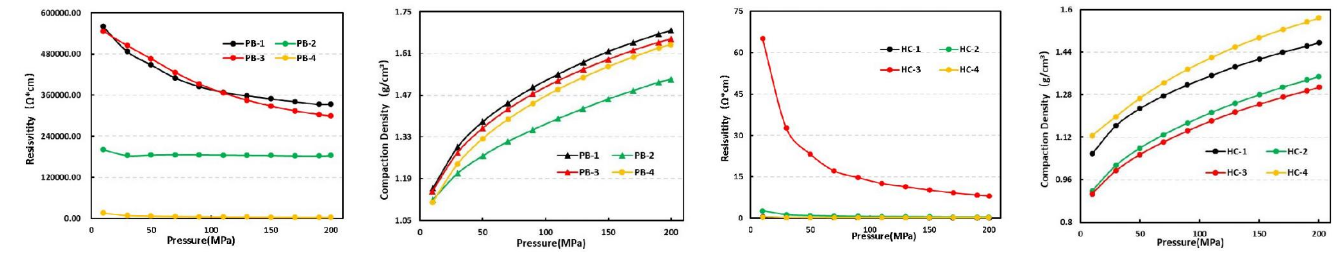
Test Condition: Si content: 3%, 6% and 10%(SiC-1/ SiC-2/ SiC-3)

Conclusion:
Resistivity: SiC-1< SiC-2< SiC-3
Compaction density: SiC-1> SiC-2> SiC-3

Test Condition: Sintering temperature of SiO Materials: SiO-1< SiO-2<SiO-3<SiO-4

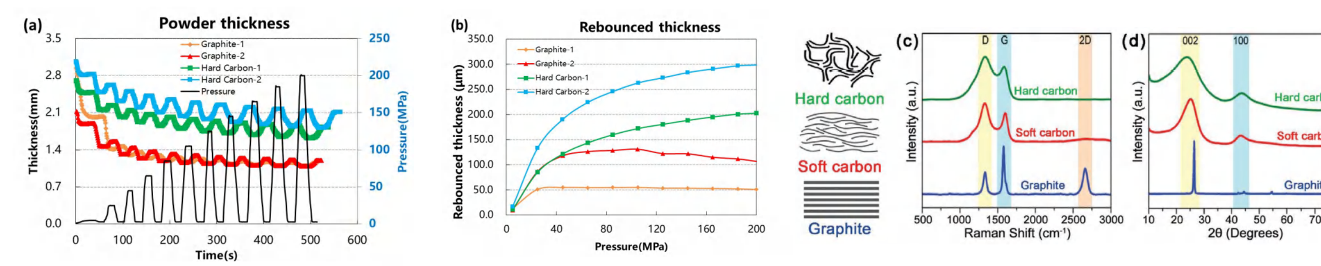
Conclusion:
Resistivity: SiC-1> SiO-2> SiO-3> SiO-4
Compaction density: SiC-1> SiO-2> SiO-3> SiO-4

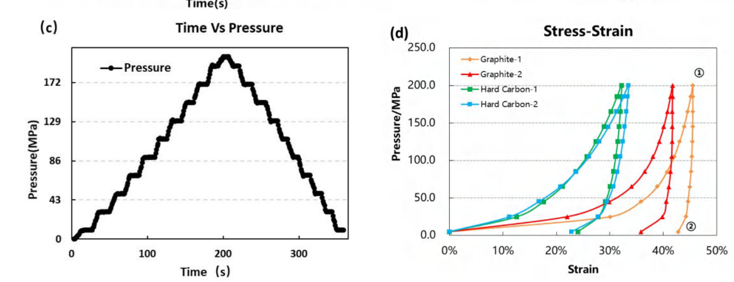
(4) Anode & Cathode Materials for Sodium ion battery



Conductivity evaluation of anode & cathode powders for sodium ion batteries : Effectively evaluate the conductivity and compaction properties of Prussian blue and hard carbon under different modification conditions.

(5) Compression properties of carbon materials



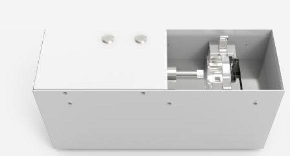


Name	Reversible Deformation	Irreversible Deformation	Max Deformation
Graphite-1	2%	43%	45%
Graphite-2	6%	36%	42%
Hard Carbon-1	8%	24%	32%
Hard Carbon-2	10%	23%	33%

Conclusion: the conductivity of graphite is greater than that of hard carbon, so is its powder compressibility.

E Testing Mold

Mold for testing



Automatic demolding instrument

Mold Parameters	
Mold material	Stainless steel, Ceramic, PEEK
Diameter	13mm/16mm
Test pressure	≤350MPa
Service life	6000 times

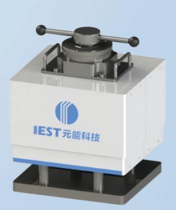
Note: Mold can be customized.

Solid Electrolyte Measurement System

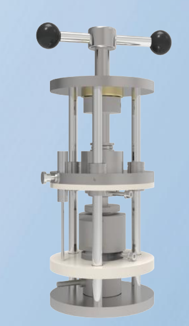
Scan QR code for details

A Creative Solutions

This instrument is suitable for testing of various types of **solid electrolytes**, such as **oxides**, **sulfides** and **polymers**.



SEMS1300



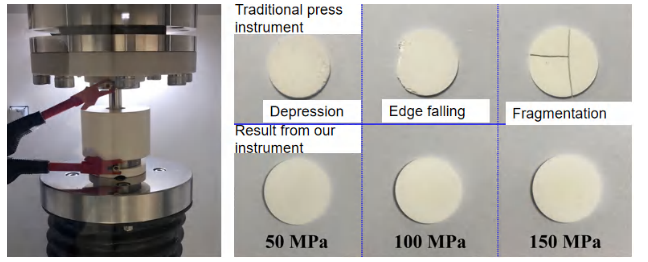
SEMS1000

SEMS1100

B Application Cases

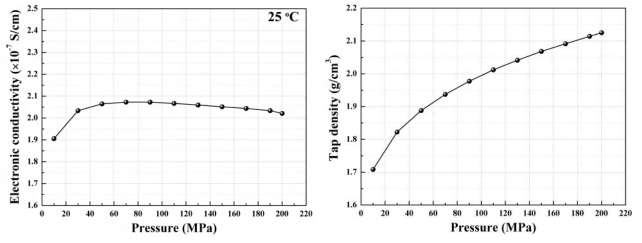
(1) Formation of Green Pellet

The equipment can be used to prepare the green pellet for solid-state batteries.



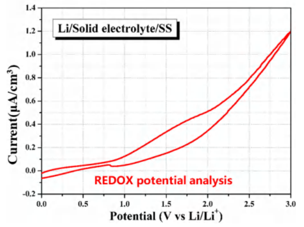
(2) Electronic Conductivity & Compaction Density

The electronic conductivity of the solid electrolyte under varying pressures can be measured using an external electrochemical impedance spectroscopy (EIS) module.



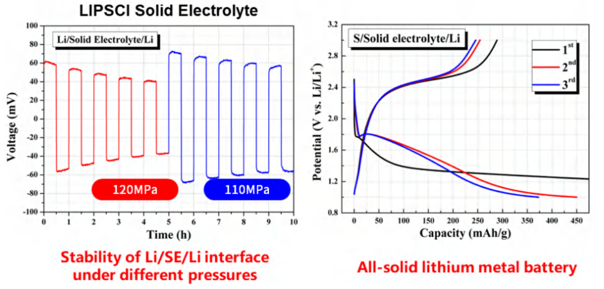
(3) Electrochemical stabilization window

Using the cyclic voltammetry (CV) module, the electrochemical stability window of solid electrolytes can be analyzed under different pressure conditions.



(4) Solid-state battery cycling performance

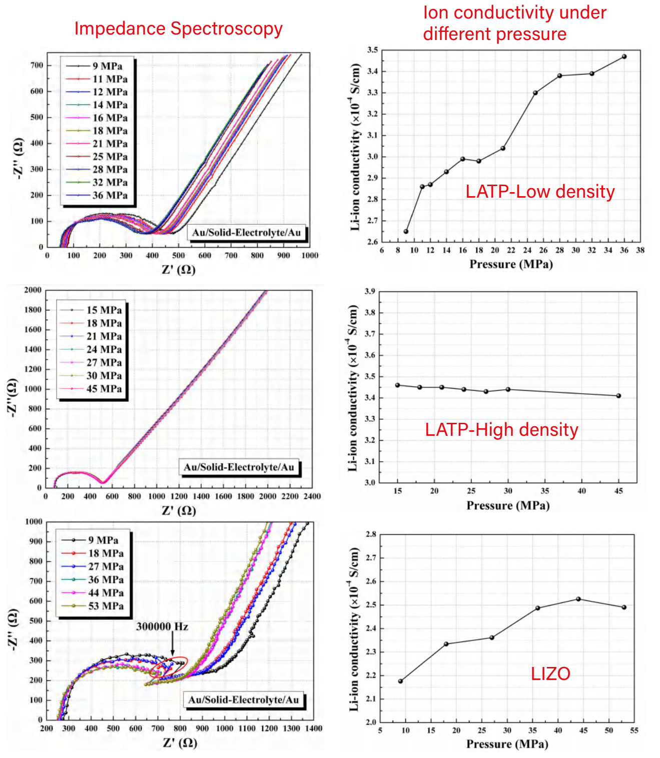
The charge-discharge (CD) module allows for the analysis of the cycling performance of solid lithium metal batteries under varying pressures and different electrochemical parameters.



(5) Ionic conductivity

Testing range: 10MHz~0.1Hz **Voltage disturbance:** 10mV

The electrochemical impedance spectroscopy (EIS) module automatically measures the ionic conductivity of solid electrolytes under varying pressures.



Battery Slurry Resistance Analyzer

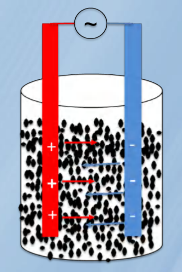
Scan QR code for details

A Slurry Resistivity Test Principle

Test Methods: Put a certain volume of slurry (~80mL) into the measuring glass, insert a clean electrode pen, start the software, start to test the change of the slurry resistivity at the three pairs of electrodes with time and save it to the file.

Main features:

1. Separate the voltage and current lines, eliminate the influence of inductance on voltage measurement, and improve the accuracy of resistivity detection;
2. The disc electrode with a diameter of 10mm ensures a relatively large contact area with the sample and reduces the test error;
3. It can monitor the change of resistivity with time at three positions in the vertical direction of the slurry in real time;



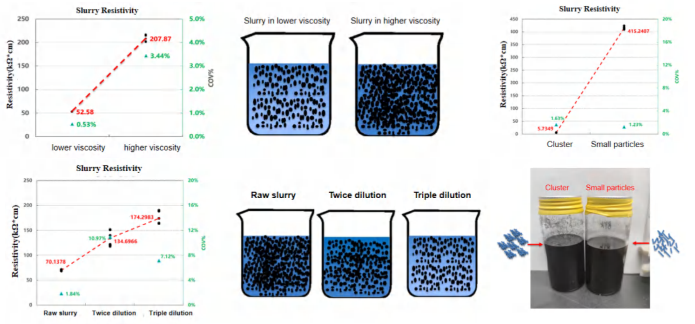
Resistivity (Ω*cm): $\rho_e = \frac{U}{I} \times \frac{S}{l}$

B Specification Parameter

Product model	BSR2300		
Resistivity range	2.5Ω*cm~50MΩ*cm	Resistivity accuracy/resolution	±5%/0.1Ω*cm
Conductivity range	0.02μS/cm~400mS/cm	Conductivity accuracy/resolution	±5%/0.01μS/cm
Temperature range	-20~120℃	Temperature accuracy/resolution	±0.5℃/0.1℃
Number of test electrodes	three pairs	Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.	

C Application Cases

(1) Evaluation of Conductive Agent Slurry with Different Formulations

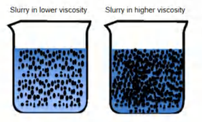


When the viscosity, concentration and dispersant type of the conductive agent are changed, the resistivity also changes!

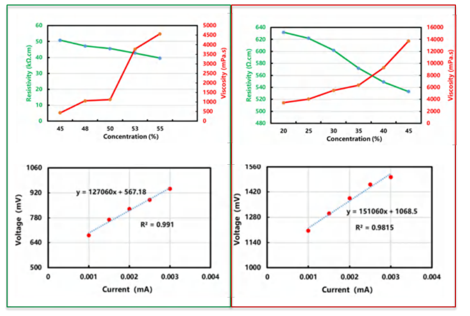
In the future, specifications can be formulated for the slurry resistivity of a certain fixed viscosity, and the stability of the slurry process can be monitored!

(2) Concentration-Viscosity-Resistivity Correlation

Slurry formula



Graphite	SP	CMC	SBR
96.5	0.5	1.5	1.5
LCO	SP	CNT	PVDF
94.0	2.0	1.0	3.0

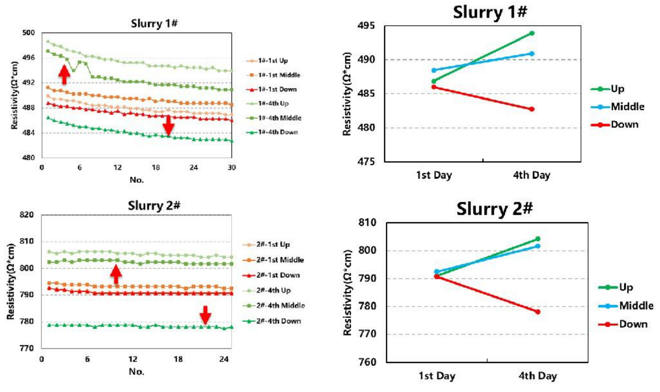


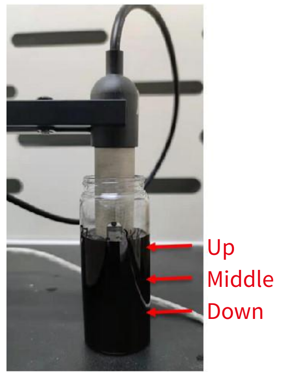
LCO Slurry　Graphite Slurry

The resistivity of the slurry decreases with the increase of the concentration, and the change of the viscosity is also inversely proportional to the relationship;

The I-V curve test of these two types of slurries basically conforms to Ohm's law, and the current and voltage have a linear relationship, indicating that the slurries are mainly electronic conductors;

(3) Slurry Settling Performance





Test resistivity with different resting time.

On the first and fourth day of testing, the resistivity of the upper and middle channels increased, while the resistivity of the lower channel decreased, indicating that after four days of shelving, the slurry shows obvious settlement.

Subsequently, a shelving period can be formulated for a certain of slurry according to the change of the resistivity to ensure the uniformity of the slurry!

Battery Electrode Resistance Analyzer

Scan QR code for details

A Differences between different models of BER series

Model	BER2100	BER2200	BER2300	BER2500
Pressure method	Cylinder (air source required, pressure range:5~35Mpa)		Servo motor(no air source required, pressure range:5~60Mpa)	
Testable parameters	Resistance, pressure, temperature and humidity	Resistance, pressure, resistivity, conductivity, intensity of pressure, temperature and humidity	Resistance, pressure, resistivity, conductivity, intensity of pressure, temperature and humidity	Resistance, resistivity, conductivity, pressure, intensity of pressure, temperature and humidity, thickness, compaction density
Feature	Single point test	Single point test Continuous testing	Single point test; Continuous testing; Variable pressure mode	Single point test; Continuous testing; Variable pressure mode
	Electrode resistance under constant pressure	Electrode resistance,resistivity, conductivity under constant pressure	Electrode resistance, resistivity, conductivity under constant pressure	Electrode resistance, resistivity, conductivity, thickness, compaction density, under constant pressure
		Fully automatic measurement software	Electrode resistance, resistivity, conductivity under different pressure	Electrode resistance, resistivity, conductivity, thickness, compaction density, under different pressure
			Fully automatic measurement software	The relationship between electrode resistance, resistivity, conductivity, thickness and compaction density,
				Fully automatic measurement software

Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.

B Testing method and principle

Test parameters: The battery electrode resistance analyzer (BER series) adopts the double-plane pressure-controllable disk electrode to directly measure the overall resistivity of the real electrode, that is, the sum of the coating resistance, the contact resistance between the coating layer and current collector and the current collector resistance.

Feature: 1.Directly measure the longitudinal resistance of the real eletrode, that is, the sum of the coating resistance, the contact resistance between the coating layer and current collector and the current collector resistance;

2.Separate the voltage and current lines, eliminate the influence of inductance on voltage measurement, and improve the detection accuracy;

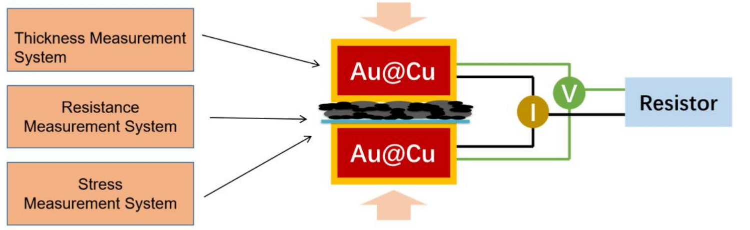
3.Equipped with standard resistance block and thickness block measured by a third-party metrology institute.

Calculation formula:

Compaction Density(g/cm^3): $D = \frac{m_{\text{Area density}}}{L_{\text{Coating Thickness}}}$

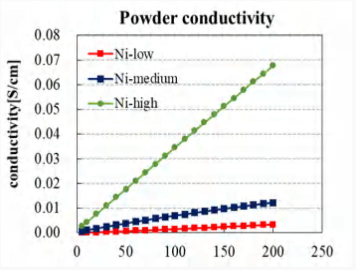
Resistance(Ohm): $R = \rho\frac{l}{s}$

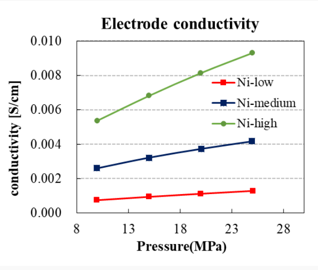
Conductivity (S/m): $\sigma_e = \frac{1}{\rho} = \frac{l}{RS}$



C Appliction-Material Evaluation

(1) Material Evaluation : Correlation between powder conductivity and electrode conductivity





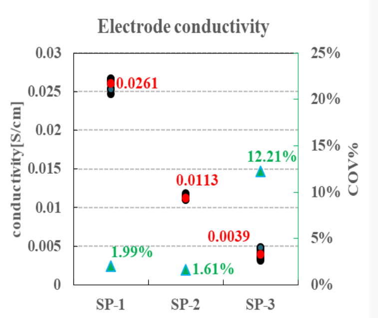
Result analysis:

①Adjust the Ni content in the ternary material, and test the electrical conductivity of the powder, it can be found that as the Ni content increases, the electrical conductivity of the powder increases;

②Comparing three ternary electrode pieces with different Ni content, it can also be obtained that the conductivity of the electrode piece increases with the increase of Ni content;

The powder conductivity and electrode conductivity have the same trend!

(2) Conductivity evaluation of conductive agents



Constant pressure test: 25MPa,hold pressure for 25s and collect 15points;

Result analysis:

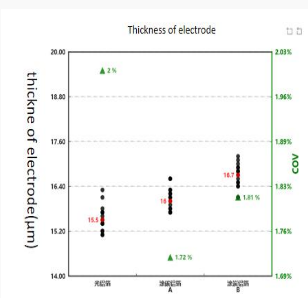
①Compared with the conductivity of three conductive agents, SP-1>SP-2>SP-3;

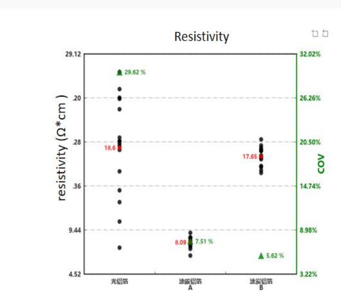
②Compared with the dispersibility of three conductive agents, the COV value of SP-3 is largest which means that the dispersion uniformity of SP-3 is poorest; the dispersibility of SP-1 and SP-2 is better;

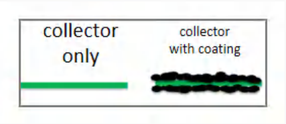
Electrode conductivity characterization can be used to evaluate the conductivity and dispersion performance of conductive agents!

* Coefficient of Variation COV = (Standard Deviation SD / Mean) × 100%

(3) Evaluation of primer coated aluminum foil: bare aluminum foil, carbon coated aluminum foil A, carbon coated aluminum foil B





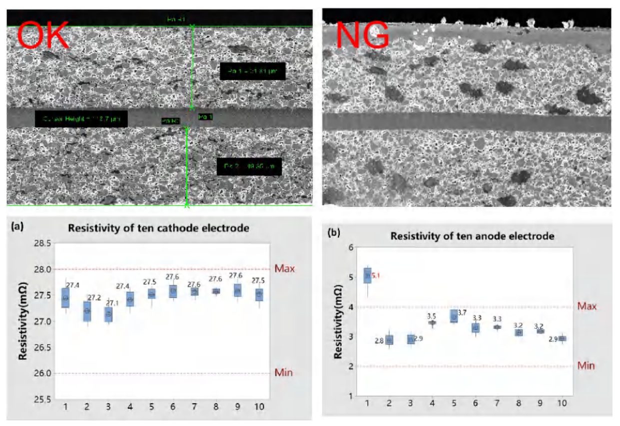


Constant pressure:
25MPa, hold pressure for 15s and collect 10points;

Result analysis:
①Different primer coating processes will change the conductivity of the current collector;
②After coating 1~2μm primer material on the aluminum foil, the conductivity uniformity of the current collector is better;

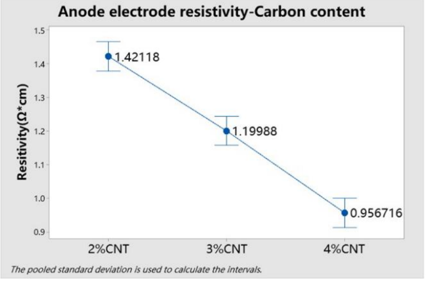
D Application Case - Process Evaluation

(1) Uniformity evaluation for the distribution of conductive agent



By using the resistance to monitor the coating quality of the electrode, an abnormal battery electrode can be quickly identified. It is useful to prevent the bad battery electrode from flowing into the process, and to save production costs.

(2) Positive and negative electrodes with different conductive agents



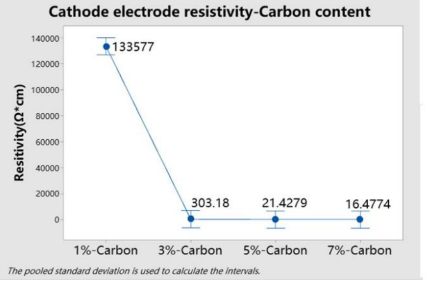
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	2	0.64767	0.323833	132.59	0.000
Error	15	0.03664	0.002442		
Total	17	0.68430			

Means

Factor	N	Mean	StDev	95% CI
2%CNT	6	1.4212	0.0609	(1.3782, 1.4642)
3%CNT	6	1.1999	0.0472	(1.1569, 1.2429)
4%CNT	6	0.9567	0.0373	(0.9137, 0.9997)

Pooled StDev = 0.0494210



Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	3	80156878491	26718959497	425.77	0.000
Error	20	1255087802	62754390		
Total	23	81411966293			

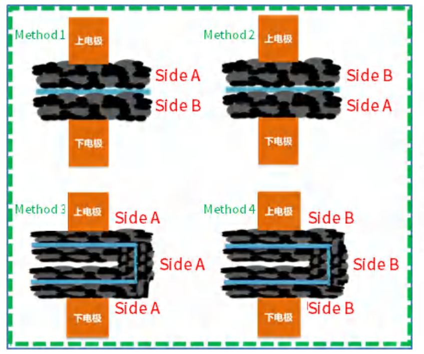
Means

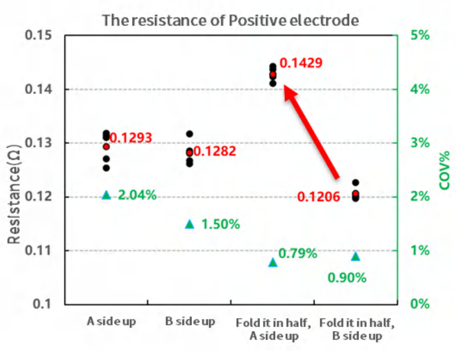
Factor	N	Mean	StDev	95% CI
1%-Carbon	6	133577	15843	(126831, 140324)
3%-Carbon	6	303.2	38.2	(-6442.9, 7049.3)
5%-Carbon	6	21.43	2.54	(-6724.68, 6767.53)
7%-Carbon	6	16.48	2.99	(-6729.63, 6762.58)

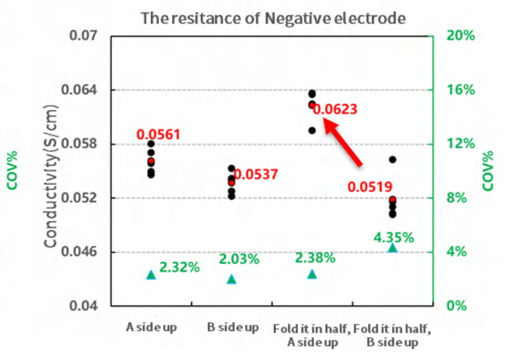
Pooled StDev = 7921.77

As the content of the conductive carbon increases, the resistivity of the ternary positive electrode decreases gradually. When the content of the conductive carbon is greater than 5%, the resistivity only decreases by a small amount. However, the resistivity of the graphite negative electrode decreases almost linearly with the increase of the content of conductive carbon.

(3) Separate the resistivity of the A and B coating layers for the double-coating electrode







① $R_{Total} = R_{A\text{-Upper electrode}} + R_A + R_{A\text{- Foil material}} + R_{Foil\ material} + R_B + R_{B\text{- Foil material}} + R_{B\text{- Lower electrode}}$

② $R_{Total} = R_{B\text{-Upper electrode}} + R_B + R_{B\text{- Foil material}} + R_{Foil\ material} + R_A + R_{A\text{- Foil material}} + R_{A\text{- Lower electrode}}$

③ $R_{Total} = R_{A\text{-Upper electrode}} + 2R_A + 2R_{A\text{- Foil material}} + R_{Foil\ material} + R_{A\text{- Lower electrode}}$

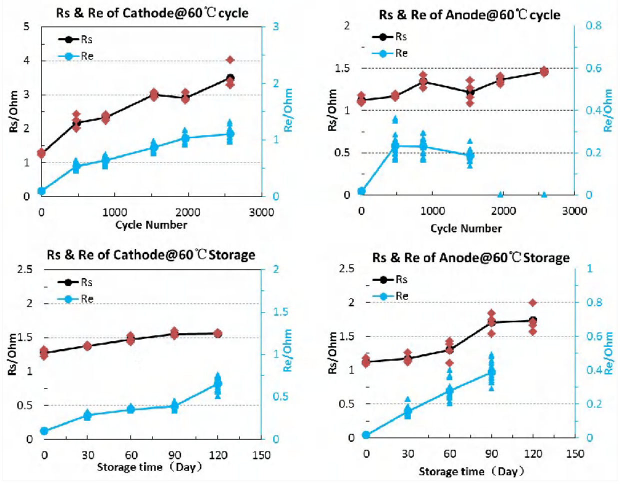
④ $R_{Total} = R_{B\text{-Upper electrode}} + 2R_B + 2R_{B\text{- Foil material}} + R_{Foil\ material} + R_{B\text{- Lower electrode}}$

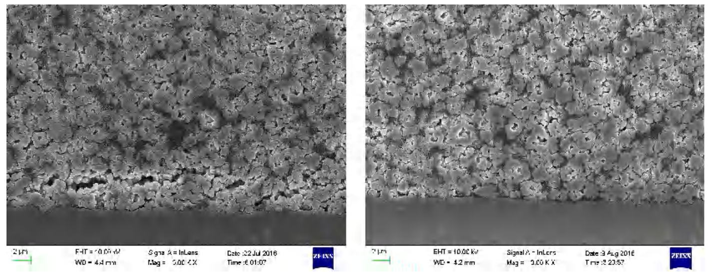
Test parameters: 25MPa test pressure, hold pressure for 15s, and test 5 parallel points for each group;

Result analysis:
①When the A side or the B side is facing up alone, the difference in the resistance and uniformity of the electrode sheet is small;
②The difference between the A side and the B side after folding is mainly due to the difference in the coating on the two sides, so this method can be used to judge the difference in the coating on the AB side;

E Application Case - Failure Analysis

(1) Analysis of electrode resistance during high temperature cycle&storage





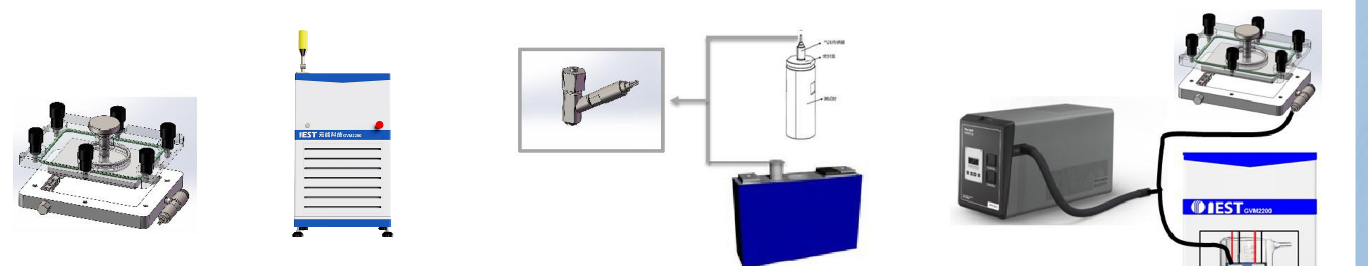
The resistance of the cathode continues to increase with the increase of the cycle numbers, indicating that a large change has taken place on the cathode side after the high temperature cycle, which may be related to the byproducts on the surface of the cathode particles or the contact between the particles;

The resistance of the anode increases with the increase of the storage time,implying that the anode side has changed a lot during the storage process, which may be related to the increase of side reactions on the anode material surface.

In-Situ Gassing Volume Analyzer

Scan QR code for details

A Complete Solution for Gas Generation in Lithium Batteries



Stacked Cell Battery Molds

Multi-Channel Gas Generation Testing Equipment

High-Precision Pressure Sensors

Combined DEMS for Gas Analysis

Product Features:

1. Multi-Level Gas Generation Testing：Material Gas Generation → Single-Layer Stacked Cell Gas Generation → Small Pouch Cell Gas Generation → Aluminum Casing Cell Gas Generation (Square or Cylindrical)

2. Multi-Channel Gas Generation Testing：Single Channel → Two Channels → Eight Channels Testing

3. Multiple Temperature Settings：Room Temperature Testing → High and Low Temperature Testing (RT to 85°C with Water Bath Control)

4. Comprehensive Gas Production Analysis：Gas Volume → Gas Pressure → Gas Composition Analysis

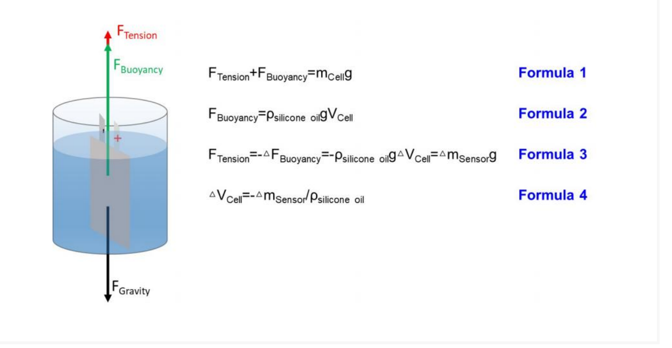
B Creative solution - in-situ gas production volume monitor

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 be compatible with supporting auxiliary system, and realize the temperature adjustment.

C Instrument Principles



By using specialized sensors to measure the real-time mass changes of a battery cell during the charge-discharge process, and by applying Newton's theorem (Formula 1) and Archimedes' principle of buoyancy (Formula 2), the volume changes of the battery cell can be further calculated (Formulas 3 and 4).

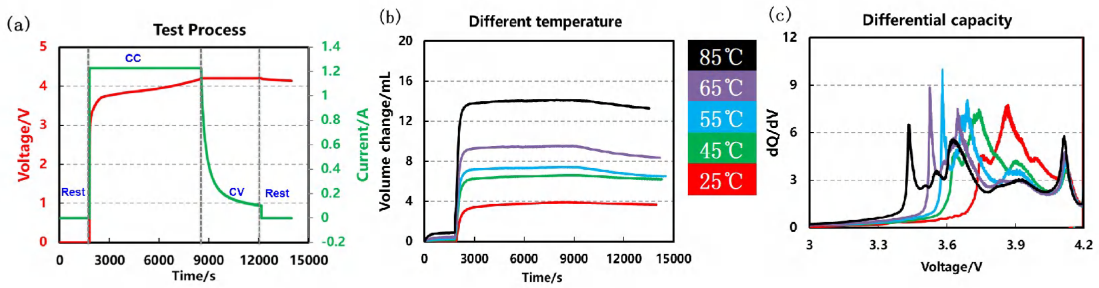
D Equipment Specifications

Model	GVM2100	GVM2200	GVM2150
Channel	Single Channel (1 Cell)	Dual Channel (2 Cells)	Single Channel (1 Cell)
Maximum Cell Weight (Including Fixture)	1000g	1000g	5000g
Test Temperature	RT~85°C	RT~85°C	RT~85°C
Volume Change Resolution	1μl	1μl	10μl
Volume Change Measurement Precision	±10μl	±10μl	±30μl
System Stability	≤20μl (RT, ≤12h)	≤20μl (RT, ≤12h)	≤50μl (RT, ≤12h)
Instrument Dimensions	502*505*800mm	502*505*800mm	502*505*800mm
Instrument Weight	60kg	70.5kg	65kg
Maximum Dimensions (Excluding Tabs): 220 × 180 mm (Custom sizes available upon request)			

Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.

E Application Case - Analysis of Formation and Gas Production

(1) Formation at different temperatures

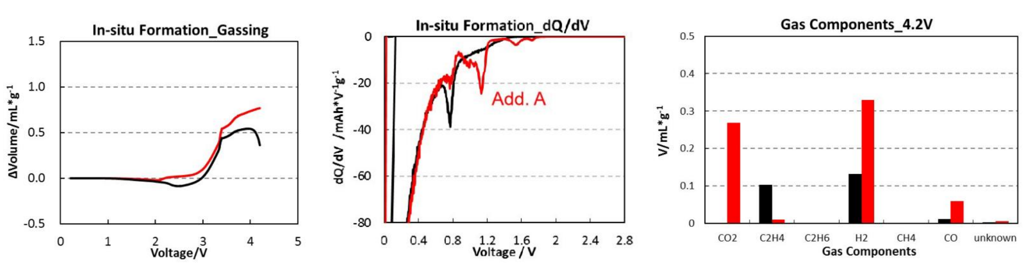


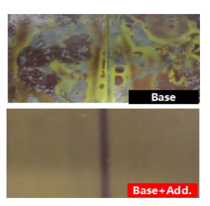
NCM/Graphite cells, 0.5C CC to 4.2V, theoretical capacity 2400mAh;

As the formation temperature increases, the corresponding gas production also gradually increases;

From the differential capacity curve, the increase of the formation temperature will reduce the polarization of each phase transition, but when it reaches above 55°C, the peak of the first phase transition will be sharper, which may be due to that the high temperature will increase the intensity of the formation reaction.

(2) Different electrolyte additive



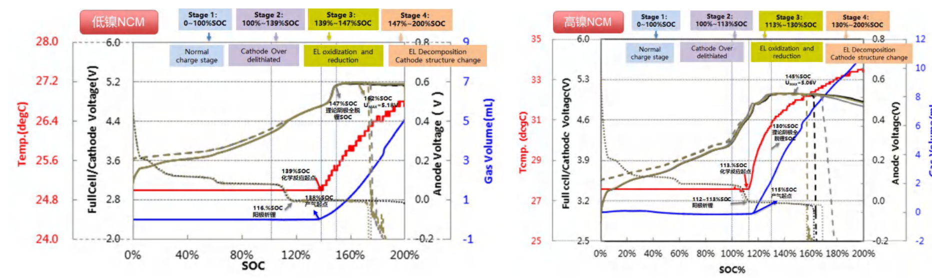


In the same electrolyte, the cell formation gas production and gas production rate of electrolyte B with a certain additive are greater than those of electrolyte A without additives. This additive can make the cell film forming reaction more complete.

The additives in the electrolyte have a great influence on the SEI film formation reaction of the cell formation stage. By comparing the changes in the gas production volume and gas production rate of the cell formation by the electrolyte with different additives, the effect of the additive on the cell formation is quickly evaluated.

E Application Case - Overcharge Gas Generation Analysis

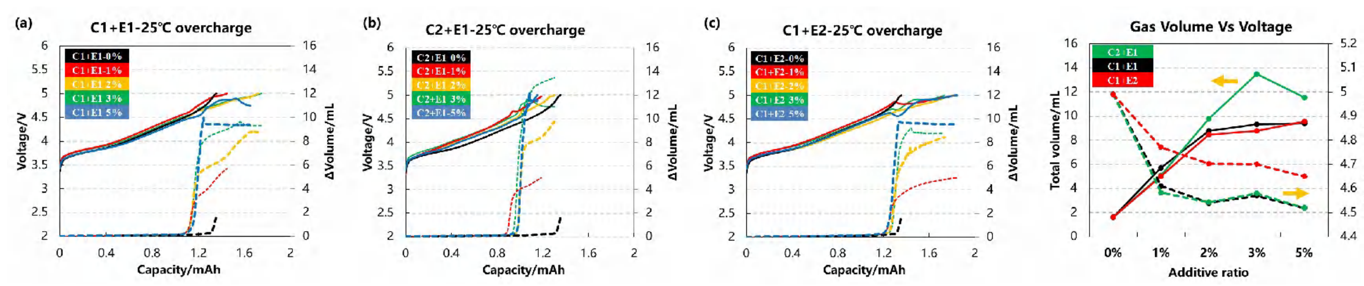
(1) Gassing Analysis for Different NCM Materials During Overcharging



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.

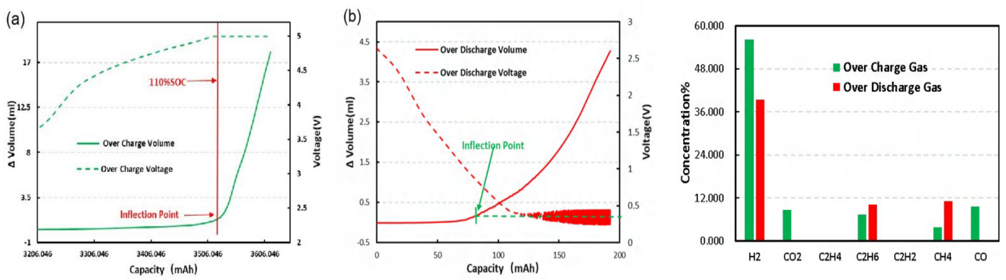
(2) Types and contents of different cathode materials and electrolyte additives



The radio of electrolyte additives	Gassing after overcharge to 5V(mL)			Voltage in gassing curve inflection point		
	C1+E1	C2+E1	C1+E2	C1+E1	C2+E1	C1+E2
0%	1.625	1.625	1.625	4.99	4.99	4.99
1%	5.708	5.068	5.005	4.61	4.583	4.77
2%	8.786	9.783	8.457	4.54	4.543	4.70
3%	9.335	13.479	8.785	4.57	4.58	4.70
5%	9.391	11.522	9.549	4.52	4.52	4.65

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.

(3) Analysis of overcharge and overdischarge of LFP batteries

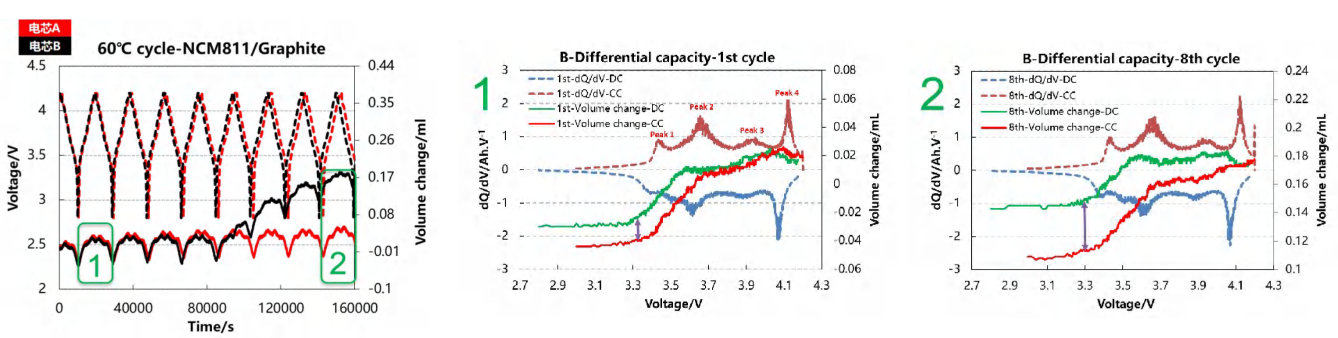


LFP/Graphite System battery;
0.5C CCCV to 5V;
0.5C DC to 0V;

As the cell is overcharged or overdischarged, the starting point of gas production can be detected in real time;
Gas chromatography analyzes the gas composition under these two working conditions. In addition to the same gas type as the over-discharge cell, a relatively high content of CO and CO_2 gas is also detected.

E Application Case - Cycling Gas Generation Analysis

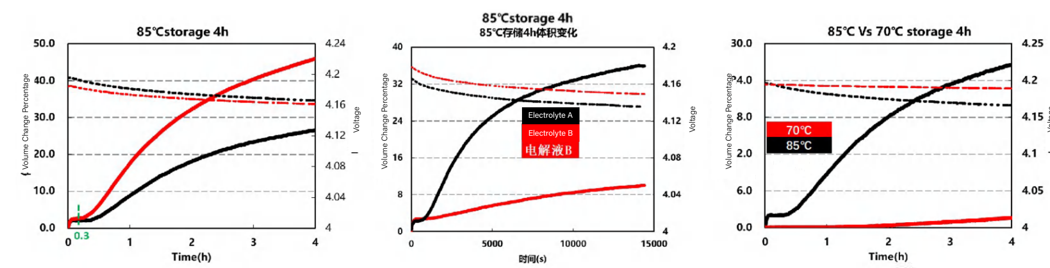
(1) Cyclic gas production analysis - comparison of different ternary materials



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.

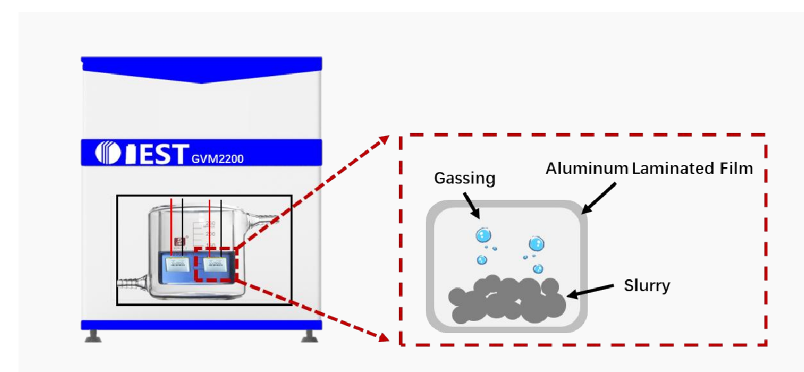
E Application Case - Storage Gas Generation Analysis

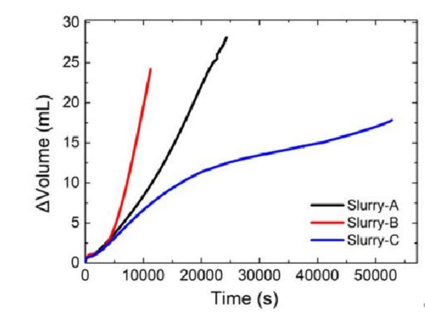
(1) Gas Production during the Storage Process



Test condition:
Storage for 4hours after being fully charged to 4.2V. Different cathode materials, electrolyte systems, and storage temperatures will affect the gas production of the cell.

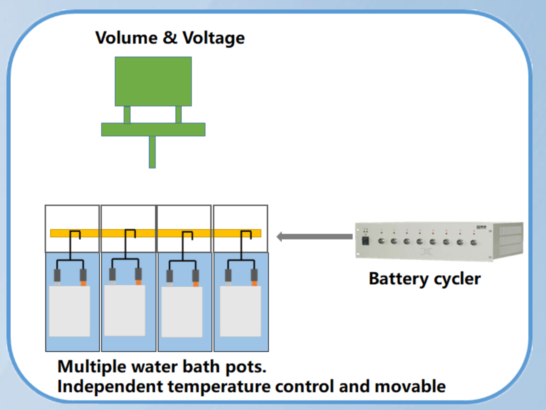
E Gas production from silicon-based slurry





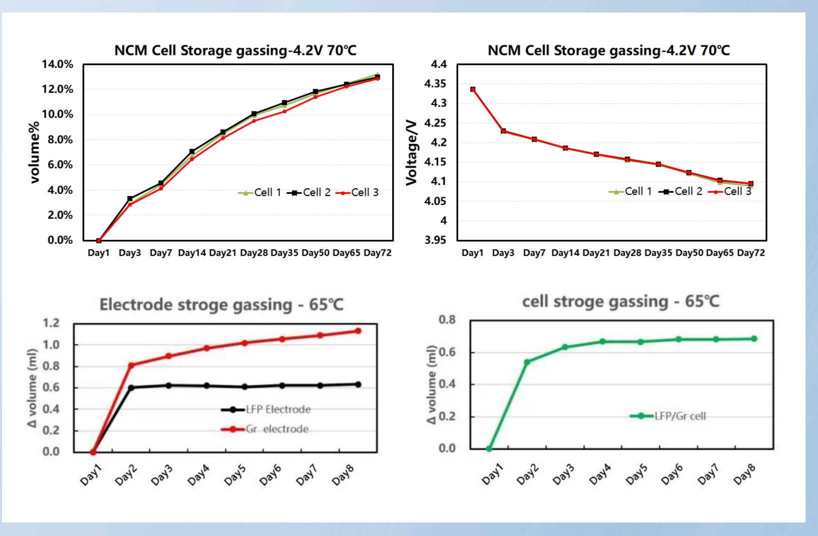
1.Silica is pre-magnesium or pre-lithiated, resulting in gas production from the homogenate;
2. The cathode electrode lithium replenishing agent is easy to decompose and generate gas during the actual homogenization and lithium replenishing process;
3. GVM can be used to characterize slurry gas production in real time.

In-situ Multi-channel Storage Gas Production Test System

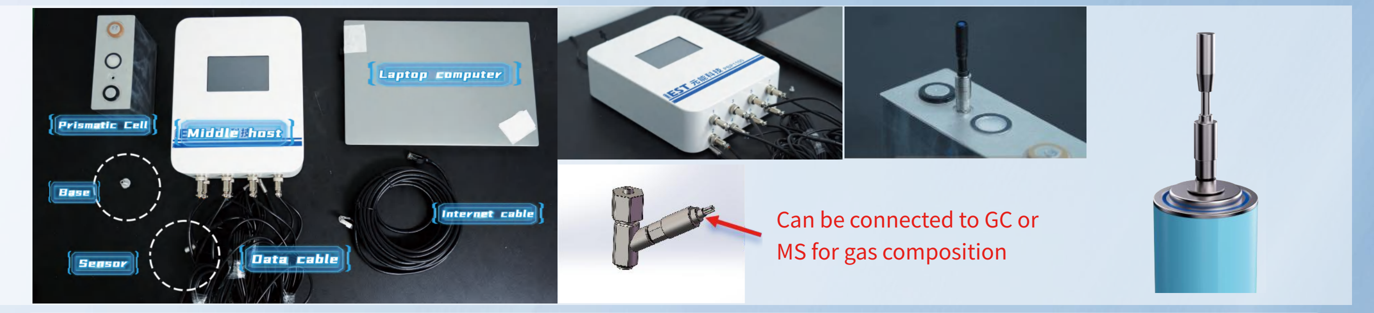


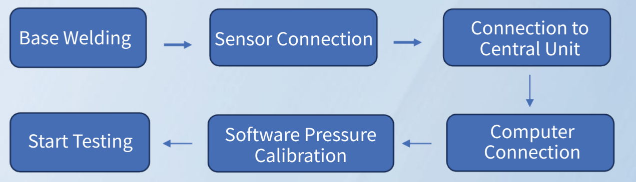
Advantages:

1. In-situ high-temperature storage testing avoids temperature errors caused by movement.
2. A barcode scanner combined with software allows for direct data recording and immediate generation of results, facilitating analysis.
3. Adapted for multi-channel storage.



Square & Cylinder Cell Internal Pressure Testing System

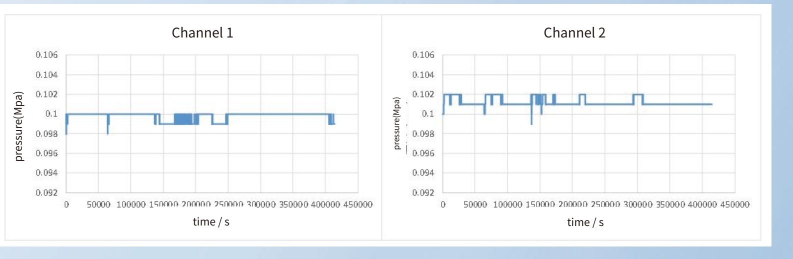




Suitable for cylindrical and prismatic batteries, with filling hole diameter: >7mm.

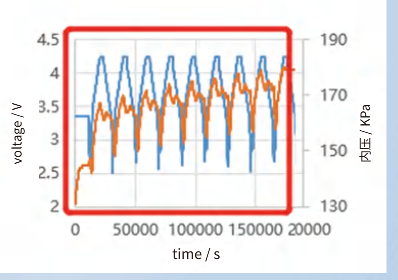
Range: 0.5MPa, 1MPa,1.5MPa,2MPa

Sensor accuracy: 0.3%F.S



Test conditions: 60°C atmospheric pressure test

Test results: 115 hours, 0.003MPa fluctuation



As the cycle count increases, the pressure value rises, and after reaching a certain level, it stabilizes for a period of time.

In-Situ Cell Swelling Analyzer

Scan QR code for details

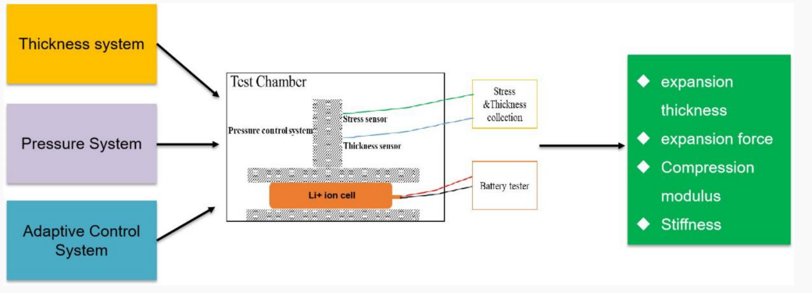
A Complete Solution for Battery/Cell Expansion

Model Coin Cell | Silicon-Based Anode | Consumer Battery | Consumer Battery & Power Battery & Energy Storage Battery | Battery Pressure Distribution Measurement System

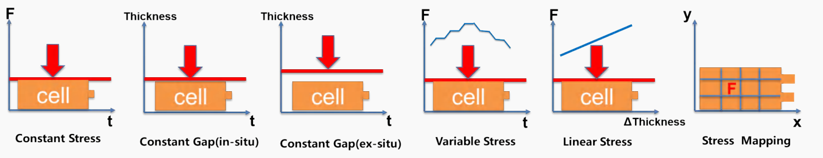
MCS series | RSS series | CBS series | CBS series & SWE series

Model coin cell | Stacked Cell | Pouch Cell | Square Cell | Short-blade Cell (<700*400*100 mm) | Solid-state Batteries

B Instrument Principles



In-situ expansion analysis system:high-precision motor + adaptive lower machine control system + high-precision pressure sensor and thickness sensor



Six test modes:Characterize the expansion behavior of the cell under different boundary conditions

C Equipment Specifications

Model Number		MCS1400	RSS1400	CBS1400
Test Mode	Constant Gap	×	×	√
	Constant Pressure	√	√	√
	Steady-State Compression	×	√	√
Compatible Battery Cell	Battery Cell Type	Coin Cell	Coin Cell / Small Pouch Cell	Coin Cell / Small Pouch Cell
	Maximum Cell Size	/	60*90mm	100*100mm
	Channel Quantity	4	4	4
Pressure Control	Pressure Adjustment Range	5kg	1-100kg	1-300kg
	Pressure Measurement Range	/	0-100kg	0-300kg
	Resolution	/	±1kg	±1kg
Pressure Measurement	Accuracy	/	±0.3%F.S	±0.3%F.S
Thickness Control	Accuracy	/	±1μm	±1μm
Battery Cell Thickness Measurement	Measurement Range	×	0~5mm	0~6mm
	Resolution	×	0.01μm	0.1μm
	Accuracy	×	±1μm	±1μm
Expansion Thickness Measurement	Measurement Range	±5mm	±5mm	±6mm
	Resolution	0.01μm	0.01μm	0.01μm
	Accuracy	±0.1μm	±0.1μm	±0.1μm
Dimension		600*315*380mm	1500*700*1650	1600*700*1650
Weight		53kg	430kg	430kg

C Equipment Specifications

Model		SWE2100	SWE2110	SWE2500	SWE2510
Test Mode	Constant Gap	√	√	√	√
	Constant Pressure	√	√	√	√
	Steady-state Compression	√	√	√	√
Applicable Cell	Cell Type	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell
	Maximum Cell Size	220*180mm	220*180mm	400*300mm	400*300mm
	Number of Channel	1	1	1	1
Pressure Control	Pressure Method	Servo Motor	Servo Motor	Servo Motor	Servo Motor
	Pressure Adjustment Range	20-1000kg	20-1000kg	50-5000kg	50-5000kg
	Accuracy	±2kg	±2kg	±3kg	±3kg
Thickness Control	Accuracy	±1μm	±1μm	±2μm	±2μm
Cell Thickness Measurement	Measurement Range	0~80mm	0~80mm	0~100mm	0~100mm
Swelling Thickness Measurement	Measurement Range	±5mm	±5mm	±5mm	±5mm
	Resolution	0.1μm	0.1μm	0.1μm	0.1μm
	Accuracy	±1μm	±1μm	±1μm	±1μm
Temperature Control	Temperature Control	√	×	√	×
	Temperature Control Range	-20~80°C	×	-20~80°C	×
	Accuracy	±2°C	×	±2°C	×
Dimension		700*1185*1750	383*415*950	1080*1620*1800	675*760*1220
Weight		490kg	200kg	840kg	350kg

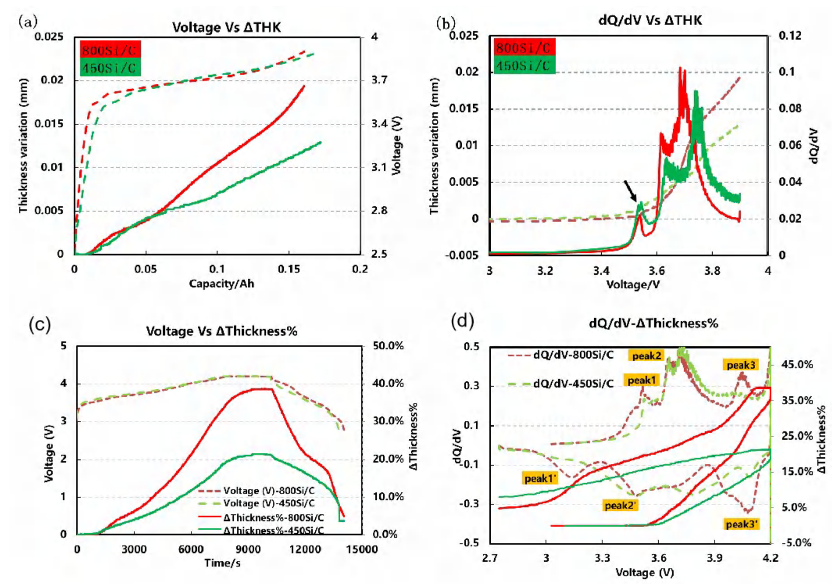
Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.

D Product Features

1. Multi-Level Expansion Testing: Electrodes, Pouch Cell, Prismatic hard shell cell, Short-blade Cell
2. Multi-Channel Expansion Testing: Single-channel → Dual-channel → Four-channel → Multi-point simultaneous testing
3. Temperature Control: -20°C—80°C
4. Wide Force Ranges: 100kg → 300kg → 1000kg → 5000kg → 10000kg

E Applications-Materials Evaluations

(1) Anode: SiC

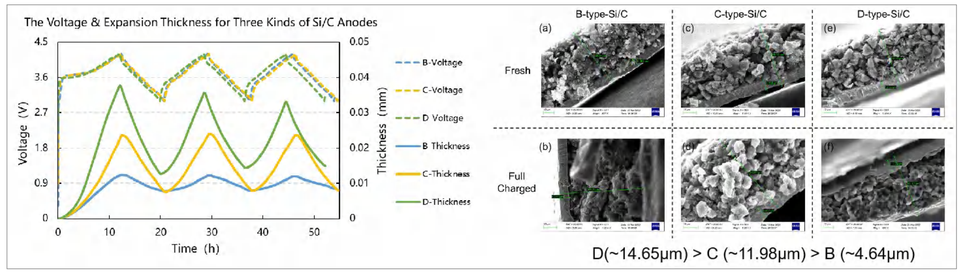


Information of battery	
Item	Parameter
Norminal capacity(Ah)	0.2
Cathode material	NCM811
Anode material	450Si/C-450mAh/g 800Si/C-800mAh/g

The higher the silicon content in the negative electrode, the greater the expansion caused by lithium ions intercalating in the negative electrode to form the LixSi alloy, and it will affect the intercalation phase transition potential of graphite.

R&D personnel should reasonably control the ratio of silicon to carbon and modify the structure of silicon-based materials to suppress structural expansion.

(2) Anode: SiC

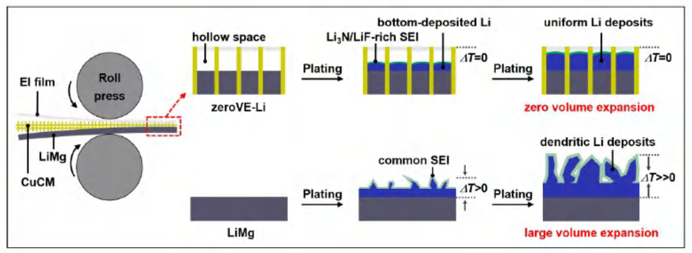


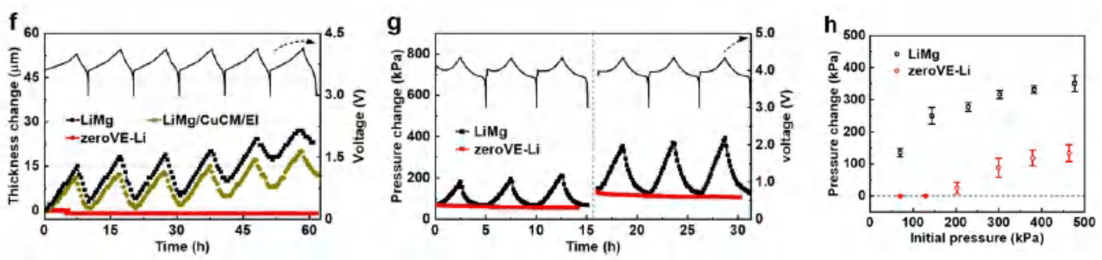
Assemble NCM-Si/C batteries and compare the expansion differences of Si/C materials with different modifications

Negative Electrode: Three types of electrodes (B, C, and D) with similar capacities (~5.9 mAh) but different Si/C modification methods (with B being a low-expansion silicon-carbon material specially modified by a battery material company in Ningbo). When using the same positive electrode material, a comparison of the expansion of the three types of Si/C negative electrodes shows that the specially modified Si/C material (B) has the least expansion.

The trend in expansion thickness for all three types is consistent with the results observed under an electron microscope.

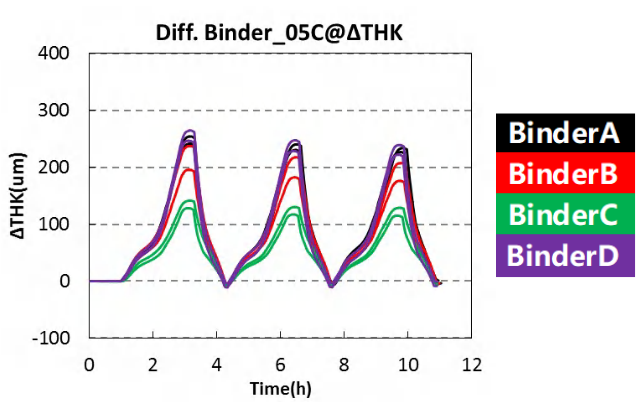
(3) Anode: Li metal

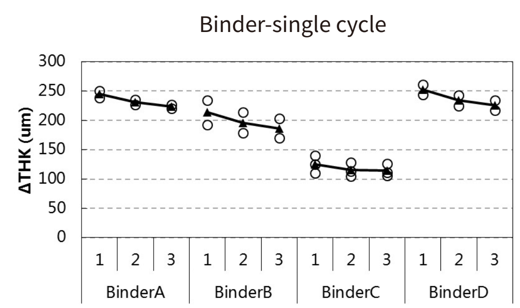


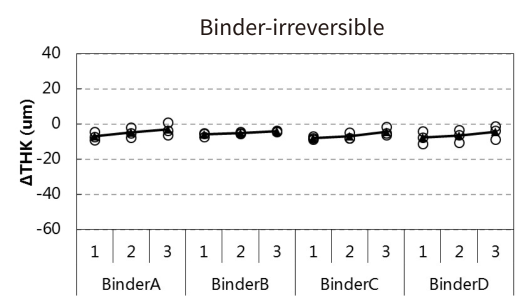


The modified lithium metal anode can significantly reduce the volume expansion of the cycle process.

(4) Binder







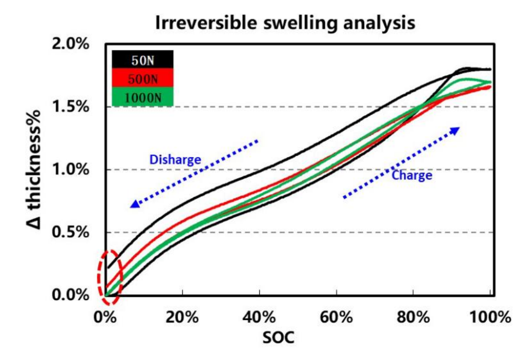
Comparison of the expansion of four different Binder material batteries, the level of irreversible expansion is the same, the main difference lies in the single-cycle full-charge expansion thickness, Binder C has the best expansion suppression effect, and can be used for evaluation and screening of different Binder materials.

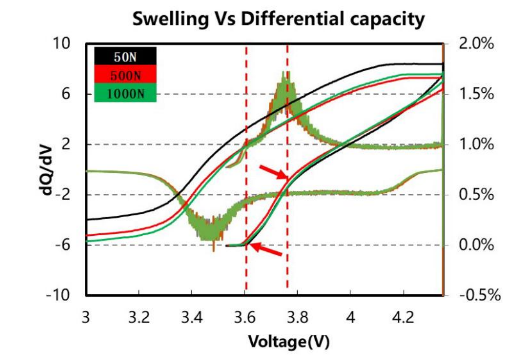
E Applications-Process Conditions

(1) Pressure

NCM523/graphite cell (3446106, theoretical capacity 2400mAh)

Different constant pressure conditions (50N/500N/1000N)





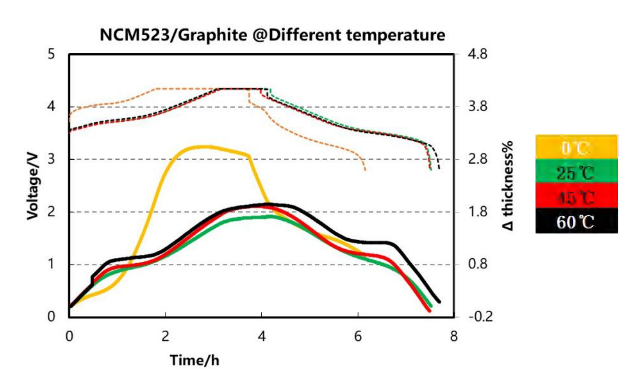
Properly increasing the pressure can reduce the irreversible expansion ratio of the cell.

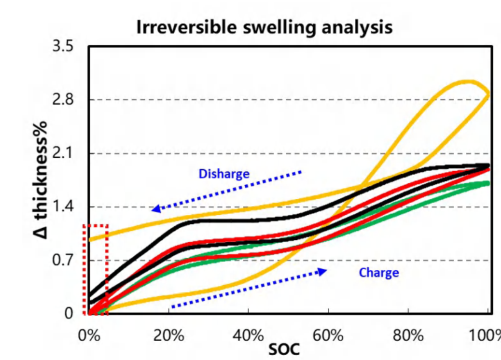
During the charging process, the two inflection points of the expansion curve correspond to the two peaks of the differential capacity curve, indicating that the expansion of the cell is related to the phase transition of deintercalation of lithium.

(2) Temperature

NCM523/graphite cell (3446106, theoretical capacity 2400mAh)

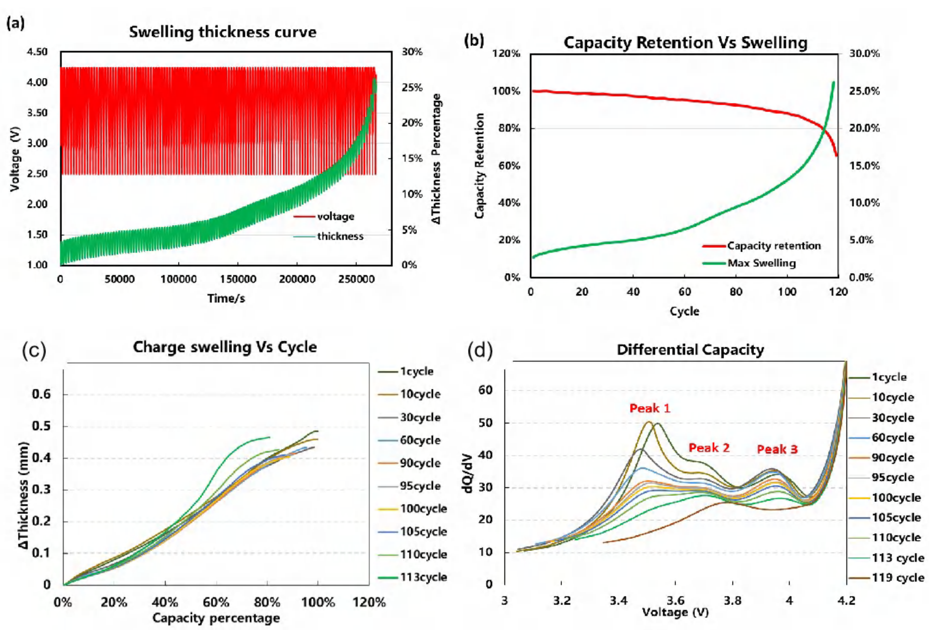
Different temperature conditions (0°C, 25°C, 45°C, 60°C)





When the temperature rises from room temperature 25°C to 45°C and 60°C, and when it drops from room temperature to 0°C, the irreversible expansion of the cell increases. However, the causes of irreversible expansion may be different under high temperature and low temperature conditions.

(3) Cycle



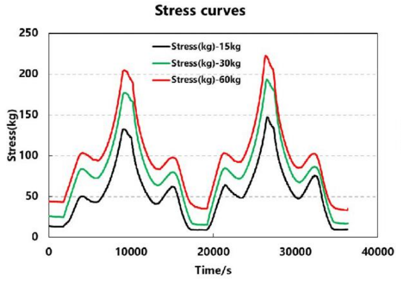
Test Conditions: 25℃ 1C 3~4.2V;50Ah NCM811-Graphite

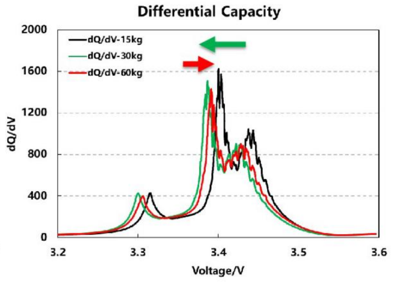
The relationship between capacity decay and thickness expansion during the long cycling of NCM cells was analyzed. Through the analysis of related expansion thickness and electrochemical data, it can be speculated that the reasons for the capacity decay of NCM cell include electrode mechanical damage, lithium plating and other side reactions.

(4) Different pre-load force: Hard-shell cell

Pre-stress(kg)	Pre-stress(kPa)	Max Stress(kg)-1st cycle	Max Stress(kPa)-1st cycle
15	5	130	51
30	10	170	67
60	20	200	79

preload (15kg, 30kg, 60kg)
Hard-shell cell of LFP//Gr.
(theoretical capacity 100Ah)



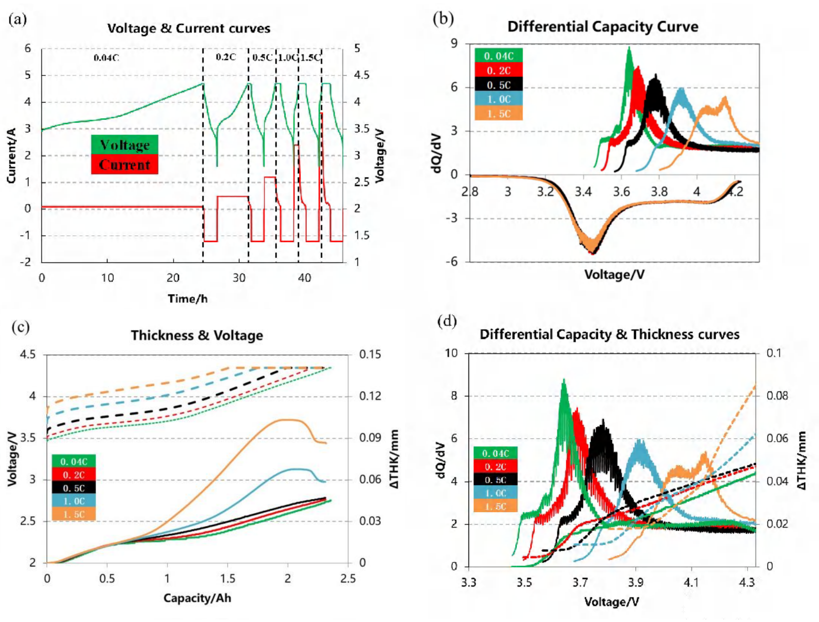


With the increase of preload, the initial gap of the cell gradually decreases, and the expansion force during the charging and discharging processes becomes larger. The relationship between the initial preload and the maximum expansion force can be further obtained to help the design of the battery module.

With the increase of the preload,the charge polarization of the battery first decreases and then increases, which shows that for the hard shell battery, a preload of about 30kg is beneficial to increase the rate performance of the battery;

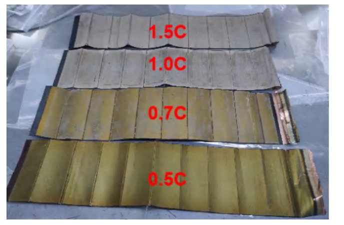
E Non-destructive lithium plating analysis

(1) Rate Window

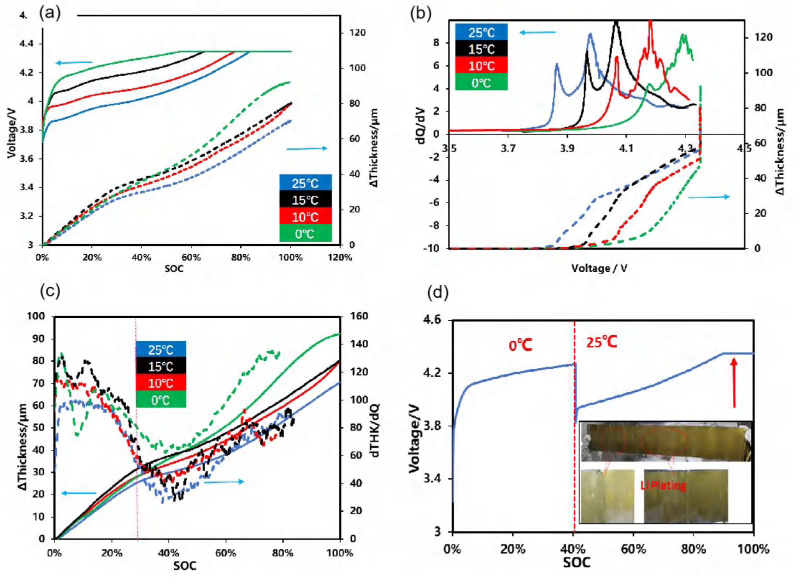


Test method: In situ detect the thickness curves of batteries with different charging rates.

Method of judgment: The thickness curve under a certain charging rate is compared with the thickness curve under a small charging rate which is without lithium plating, and the crotch position can be judged as the rate window of the lithium plating.

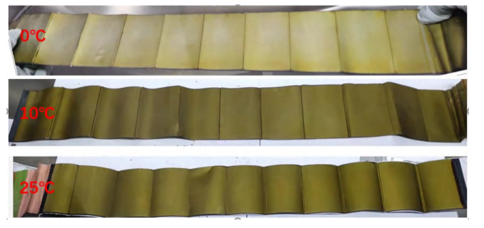


(2) Temperature Window



Test method: In situ detect the thickness curves of batteries with different temperatures.

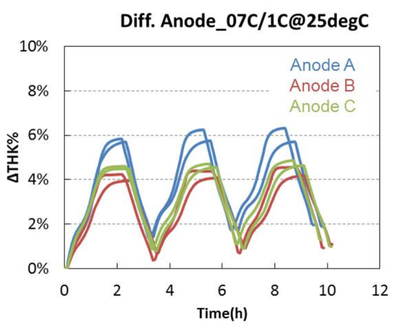
Method of judgment: The position where the thickness curve at a certain temperature bifurcates compared with the thickness curve under high temperature which is without lithium plating is the temperature window of the lithium plating.



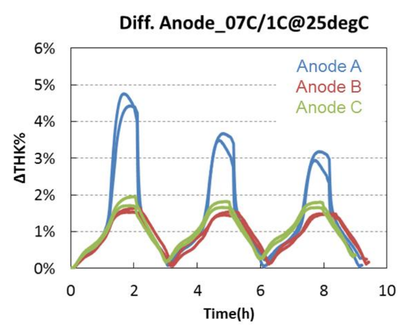
E Applications-Cell structure

(1) Structural comparison

Winding cell expansion



Stacked cell expansion



Two models are used to evaluate the swelling of different anode cells, and the comparison result is almost the same, which is A > C > B.

Because the two sides of the rolled cell are bound, the expansion stress will accumulate to the middle of the cell, which causes the increase of the thickness during the cycling. However, the four sides of the stacked cell are not restricted, so the expansion stress could be released during the cycling (Single-sided anode).

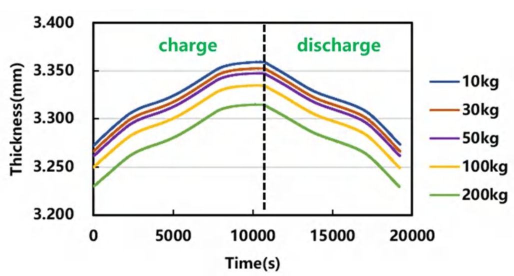
In-situ Swelling data can be used to deeply analyze the influence of the cell structure on stress and strain.

In-situ Swelling can be used to deeply analyze the influence of process on stress and strain.

(2) Expansion stiffness VS Compression stiffness

Cell：LCO/GR 2400mAh

Mode：Constant pressure

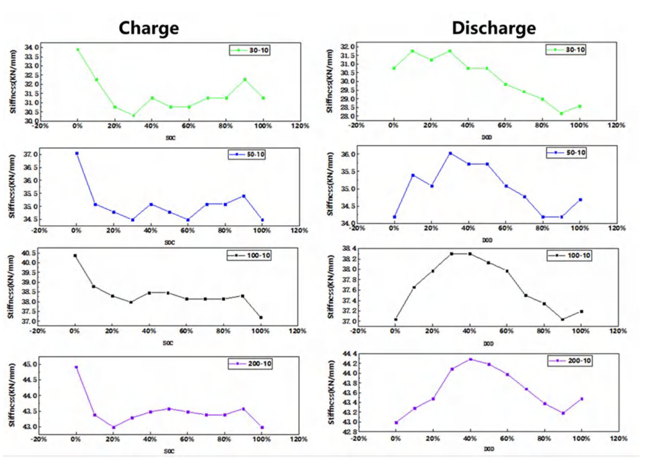


Compression stiffness

SOC \ stress / stiffness (KN/mm)	30-10	50-10	100-10	200-10
0%	40.8	42.6	51.7	62.1
30%	90.9	64.5	67.7	75.7
50%	71.4	45.5	59.2	67.6
80%	83.3	66.7	69.8	77.6
100%	71.4	61.5	65.2	69.6

Expansion stiffness

SOC \ stress / stiffness (KN/mm)	30-10	50-10	100-10	200-10
0%	33.9	37.0	40.4	44.9
30%	30.3	34.5	38.0	43.3
50%	30.8	34.8	38.5	43.6
80%	31.3	35.1	38.1	43.4
100%	31.2	34.5	37.2	43.0

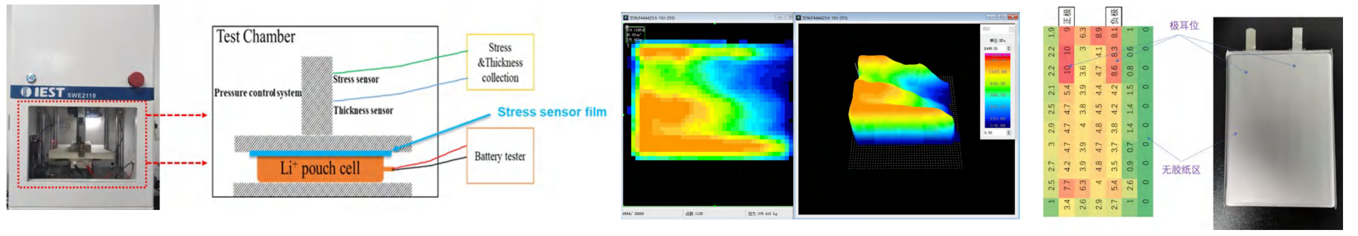


The expansion stiffness changes regularly with charging and discharging.
The difference between expansion stiffness and compression stiffness is obvious.

E Application Cases – Expansion Force Distribution

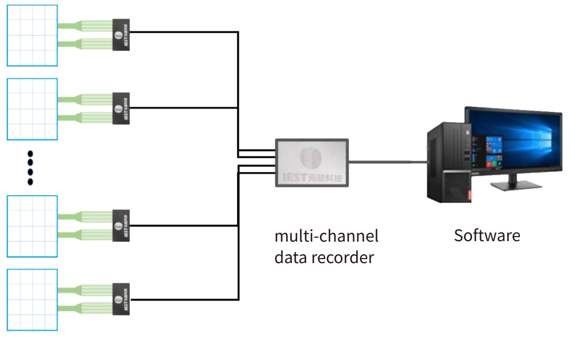
(1) Application

1. Use the expansion equipment & mould to see the force distribution during the charging and discharging process of the cell.
2. Check the uniformity of pressure distribution in the hot press machine.
3. Module cell expansion force distribution.

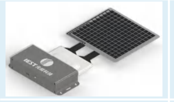


(2) Features

1. The total force of each sensor can be displayed in real time as the curve changes with time.
2. The total force of each sensor can be displayed in real time as the curve changes with time.
3. Can synchronize charging and discharging data in real time.
4. Data reports can be exported with one click.



Distribution film + data collector

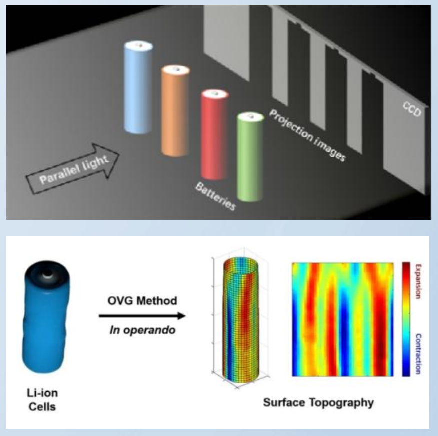
Image	Model	Range (MPa)	Points Supported	Precision	Thickness	Collection Equipment	Software
	BPD1000	0-5MPa	Single point 7.5mm*7.5mm (the specific number of points is calculated according to the required area)	12%	≤0.35mm	Scanning frequency：1Hz Equipmentweight：less than 5KG Data transmission：USB2.0	Only support 2D
	BPD1100-M	0-2MPa，0-3MPa 0-5Mpa	It's able to support up to 2288 points,but it needs to be convertedaccording to the area. It can supportup to 248/cm2²	3%~10%	≤0.35mm	1.Data transmission：USB2.0 2.Equipment interface：quick self-lockingaviation plug interface 3.system power consumption：2.5w (5V,0.5A) 4.Scanning frequency：MAX 100Hz 5.pressure resolution：256 (8bit) 6.Equipment weight:：less than 1KG	1. Pressure lattice, 2D and 3D three-dimensional color scale images. 2. Real-time pressure distribution data automatic analysis function, recording and storage. 3. Able to record and stop, load recording files, fast forward, rewind, and slow playbackPressure distribution images, mountain contours, thermal images. 4. Real-time display of the pressure value of each sensing unit, pressure data area, and pressure and time curves,etc. 5. Pressure distribution data import and export,etc. 6. Select a more suitable rangeaccordina to the application scenario software.
	BPD1100-L	0-2MPa,0-3MPa, 0-5Mpa	It can support up to 9152 points. butit needs to be converted according to the area. It can support up to248/cm2²	3%~10%	≤0.35mm		

Multiple Measurement Ranges, Multiple Sensing Points, Multiple Software Features!

Cylindrical Battery In-Situ Volume Swelling Testing System

Scan QR code
for details

A Product Features



- Optical Imaging + 3D Reconstruction + Real-time Online Monitoring
- Non-contact, Non-destructive
- High-throughput testing, suitable for mass production

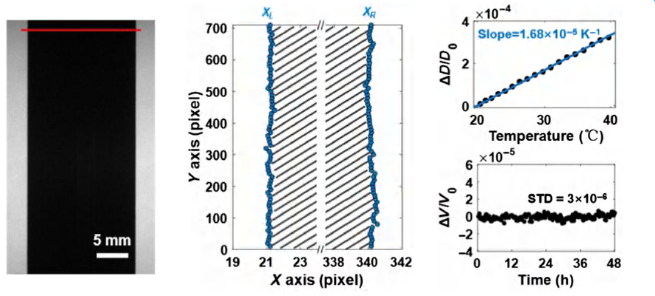
Real time reconstruction of battery surface morphology and calculation of volume deformation during charge and discharge processes. Combining voltage and current data to detect and predict battery health condition from a higher dimension.

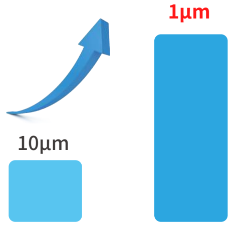
B Model Specifications Table

CCS1300-4					
Compatible Cell	Channel Number	Optical Detection Resolution	Optical Detection Accuracy	Weight	Size(W×D×H)
Cylindrical Cell	4	0.1μm	±1μm	50kg	500x230x360 mm

C Leading Technology

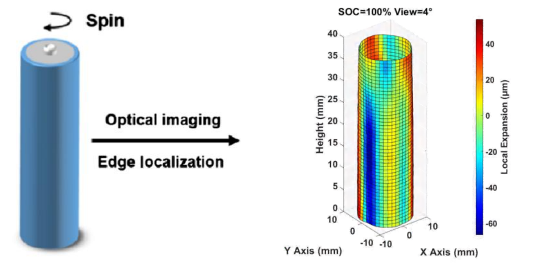
High-precision Detection Technology

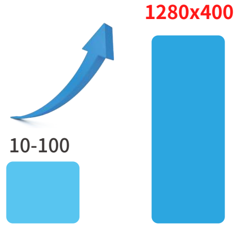




Measurement accuracy increased tenfold

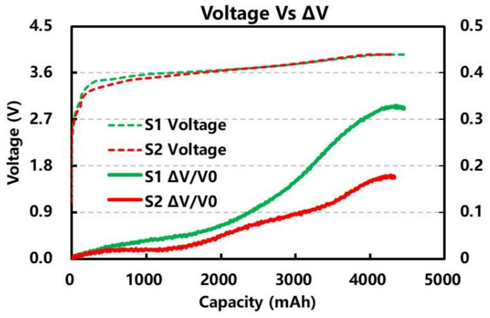
Rotational 3D Reconstruction Technology

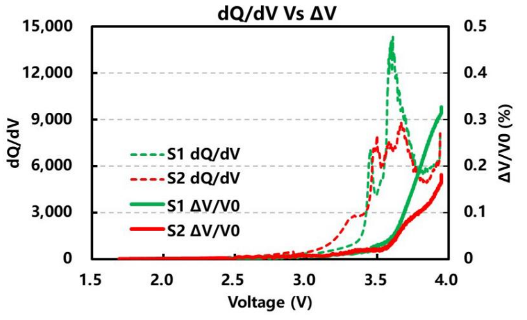




The number of sampling points increased by ten thousand times

D Application Case





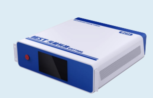
21700 Cell parameters:Sample 1-15%SiC；Sample 2-10%SiC

The volume swelling curve during formation shows that as the silicon content increases, the volume swelling during formation process increases, and the peak corresponding to lithium intercalation on the differential capacity curve becomes higher.

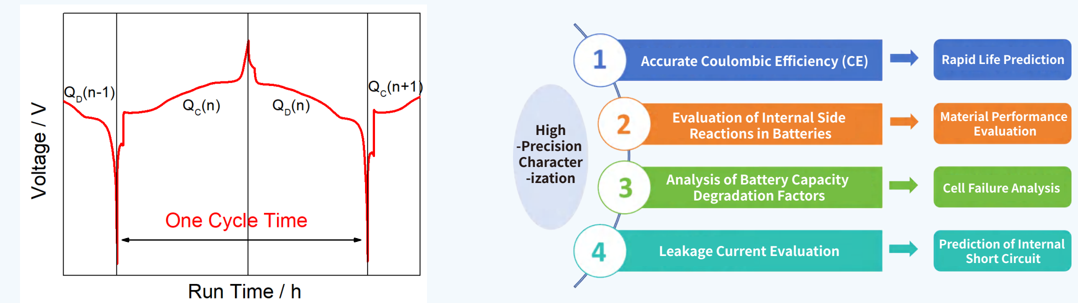
Electrochemical Property Analyzer

Scan QR code
for details

A Model Parameter Table

	ECT6008 Series		ERT7008 Series	
Physical picture				
Product model	ECT6008-5V100mA	ECT6008-5V12A	ERT7008-5V100mA	ERT7008-5V12A
★CV&LSV test	/	/	√	√
★EIS test	/	/	100k ~0.01 Hz	100k ~0.01 Hz
★EIS Applicable battery type	/	/	Button battery & symmetric battery & pouch cell	Button battery & symmetric battery & pouch cell
Number of channels	8	8	8	8
Voltage Range	±5V	±5V	±5V	±5V
Current range	10mA / 100mA	6A / 12A	10mA / 100mA	6A / 12A
Temperature range	-20~80℃ (Temperature chamber)			
Test accuracy	±0.01% F.S (Full scale range)			
Current range	4 measurement range (automatic switching)			
Maximum sampling rate	100 SPS			
Response time	1ms			

B High-Precision Current & Voltage Testing

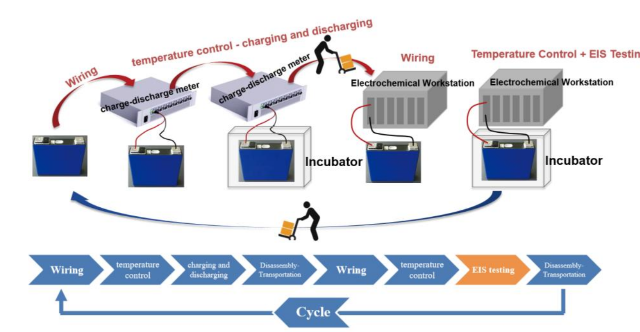


The 0.01% testing accuracy can precisely measure the specific capacity of new materials and detect subtle side reactions during the initial stages of battery cycling. This allows for a comprehensive performance evaluation and lifetime prediction of the battery in a short period.

C CV&EIS + Battery Cycler

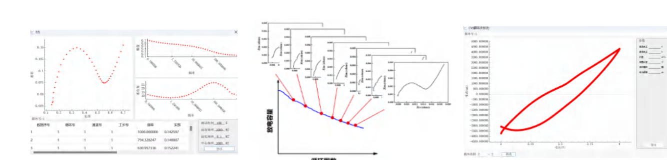
Traditional methode

Disadvantages: Time-consuming handling and excessive human interference.



IEST Methode

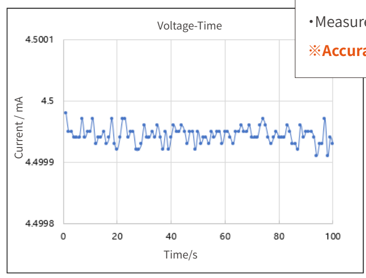
Advantages:Single wire connection, integrated test-steps setting.



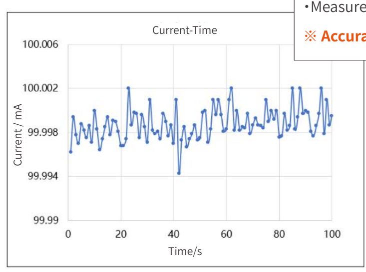
EIS Test EIS Testing During Cycles CV Test

Minimize wiring, handling, and temperature adjustments, streamline operations

D IEST Innovative Solutions



Example of constant voltage control
•Set value: 4.5V
•Measured value: 4.5V ± 100μV
※Accuracy set at below 0.01%



Example of Constant Current Control
•Set value: 100mA
•Measured value: 100mA ± 5μA
※ Accuracy within 0.01% of the set value

ECT & ERT Series Products

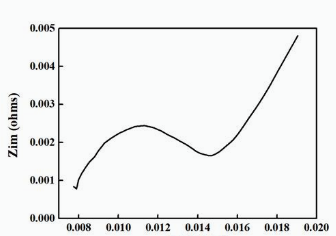
Product	Test Items	Function
ECT/ERT All Series	Constant current, constant voltage, constant power, constant resistance, rate mode, etc.	Conventional charging and discharging functions
ECT/ERT All Series	Capacity-cycle curve, dQ/dV curve, dV/dQ curve, etc.	Study the relationship between the diffusion process of matter and charge transfer
ECT/ERT All Series	PITT、GITT、DCIR	Study the relationship between the diffusion process of matter and charge transfer
ECT/ERT All Series	CA、CP	Record the change of potential/current with time under constant current or constant voltage
ERT All Series	CV、LSV	Apply linear voltage and record current-voltage curve
ERT-6Series/ ERT-7Series	EIS	Study the relationship between electrochemical impedance and frequency

Equipped with a 24-bit ADC and 16-bit DAC, achieving high-precision voltage and current control and testing.

E Offers common functions of an electrochemical workstation

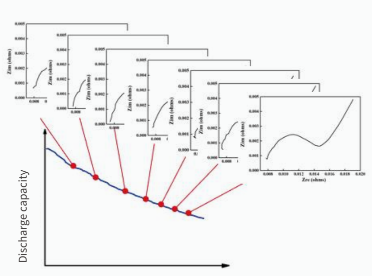
The ERT series includes common electrochemical workstation functions such as CV, LSV, EIS, CA, and CP.

Case 1: EIS Test

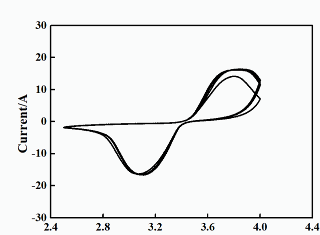


2.2Ah Pouch cell Impedance Test
[Frequency: 1500Hz～0.1Hz]

Case 2: Cyclic EIS Test

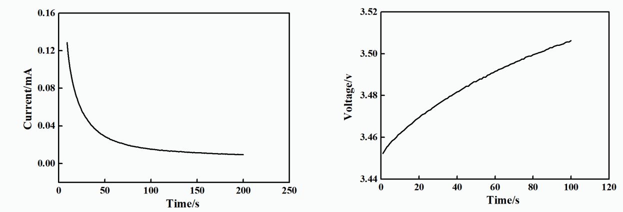


Case 3:
CV (Cyclic Voltammetry) Test



CV test of 120mAh Pouch cell
[Scan speed: 1mV/s]

Case4: CA·CP Test



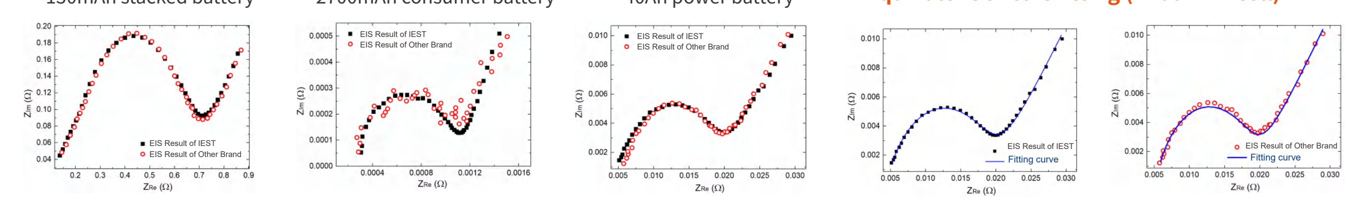
120mAh Pouch cell CA Test　120mAh Pouch cell CP Test

EIS
CV
LSV
CA
CP
GITT

Eliminates switching time between instruments

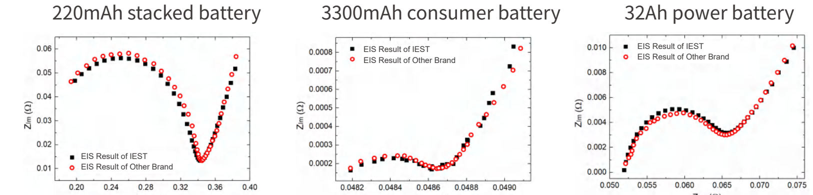
F Comparison of EIS results with other electrochemical workstations

130mAh stacked battery　2700mAh consumer battery　40Ah power battery　Equivalent circuit fitting (2700mAh cell)



Comparison with well-known foreign brand A electrochemical workstations

220mAh stacked battery　3300mAh consumer battery　32Ah power battery



Comparison with well-known foreign brand B electrochemical workstations

Fitting parameters	IEST	Others	COV(%)
Rs	0.00444	0.00426	2.07
Rct	0.0152	0.0147	1.67
CPE-T	0.8725	0.8257	2.76
CPE-P	0.7446	0.7636	1.26
Warburg Coff.	88.27	88.55	0.15

- EIS test results show COV within 2%, ensuring high reproducibility compared to other workstations.
- Better SNR in large cell testing than workstations without current amplifiers.

Battery Consistency Screening

Scan QR code
for details

A Model Parameter Table

	BCS6000
Number of Channel	1
Independence	Use independently
Current limit	100A
Application scenario	Monitor battery consistency during OCV testing process
Voltage accuracy	0.01%
EIS test range	1500Hz ~ 0.1 Hz
Impedance test accuracy	<0.01mΩ
Applicable battery capacity	EIS test for battery with capacity of 1~500Ah
OCV Test	√

Note: IEST prioritizes continuous product updates; therefore, technical specifications are subject to change without prior notice.

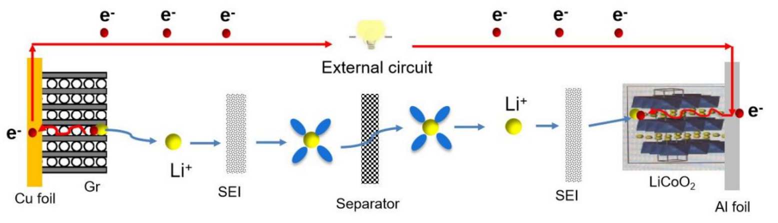
B Background and significance of battery cell consistency testing before shipment

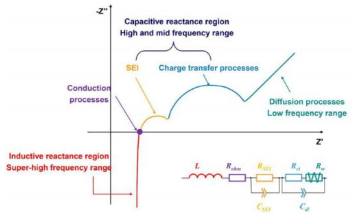
In new energy vehicles or energy storage power stations, lithium batteries are often used in the form of multiple parallel modules or packs. Therefore, high consistency requirements are placed on the battery cells in the same module or pack. Otherwise, thermal runaway may occur easily due to overcharging/overdischarging of a certain battery cell, leading to many after-sales problems.

Electrochemical impedance spectroscopy (EIS) has good sensitivity and correlation with the SOC, SOH, internal temperature, internal short circuit, etc. of the battery cell. By using fast EIS testing and neural network algorithm modeling, you can effectively screen the consistency of the battery cells and help the cascade utilization of the battery cells.

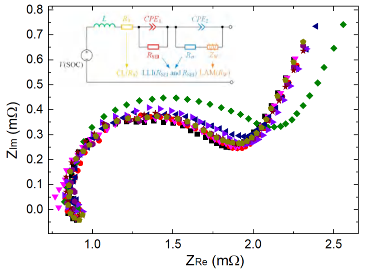
C Creative Solution

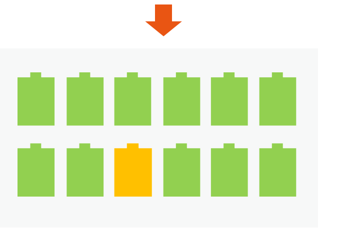
Electrochemical impedance spectroscopy (EIS) can be used to characterize the resistance of electrochemical processes with different time constants. Introducing EIS testing before battery shipment or after battery delivery, and comparing the impedance differences between different batteries, can (1) screen the consistency of batteries; (2) find abnormal batteries; (3) help analyze the failure mechanism of batteries!





Item	Description	Time	R
Electronic transportation	① Between active materials ② On the collecting fluid ③ On the external circuit	Extremely fast	Rs
Ion transport	① Solvation and Desolvation	fast	\
	② Passing through SEI membrane	fast	R_{SEI}
	③ Diffusion in electrolyte	Related to concentration	Rcp
Electron & ion binding	① Electrochemical reaction	slow	Rct
	② Diffusion in solids	Extremely slow	Rcp





D BCS6000 Introduction

Functions & Features：

① Wide range of applicable cells, ranging from 1Ah to 500Ah；

② Fast EIS frequency sweep testing, with a frequency range of 1500Hz ~ 0.1Hz；

③ Equipped with OCV testing, DCR testing, constant current charge-discharge testing, etc.;

④ Battery Consistency Screening；

⑤ Dynamic fitting screening algorithm for batch screening.

Appearance

Screening Principles：

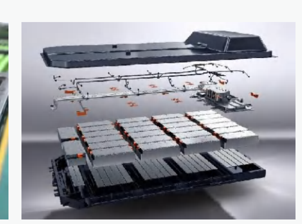
Analyzing the impedance of electrochemical processes with different time constants → Impedance comparison in different frequency bands → Consistency screening, abnormal battery warning

E Application Scene

Scene 1：Battery shipment, OCV stage consistency assessment

Full Detection on the OCV or ACIR Testing Segments

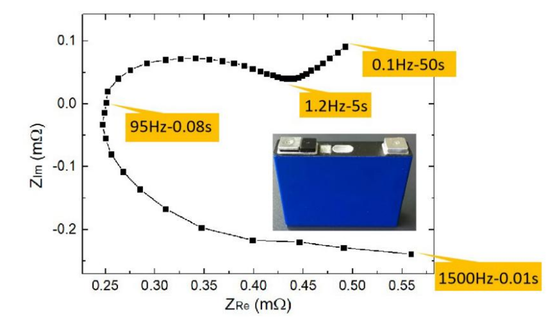
Scene 2：Consistency testing of incoming battery materials



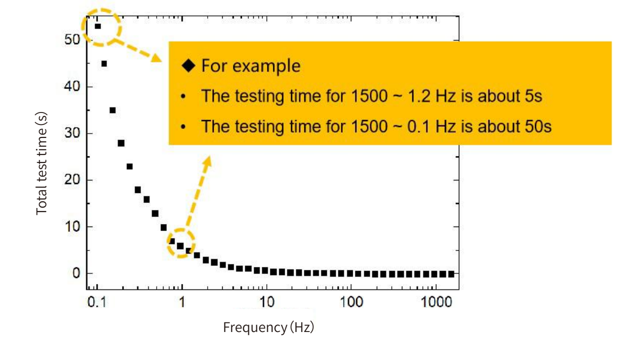
Battery Incoming Quality Control Before Grouping / Packing

F Application Cases

EIS test of LFP battery with Capacity of 280Ah (1500 Hz~0.1 Hz)

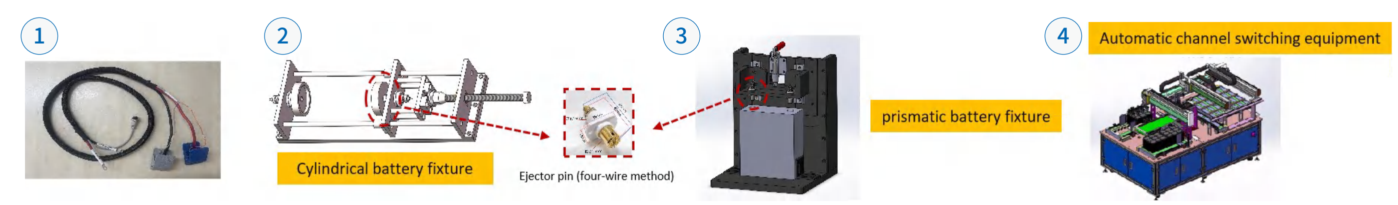


Frequency vs. Total Test Time

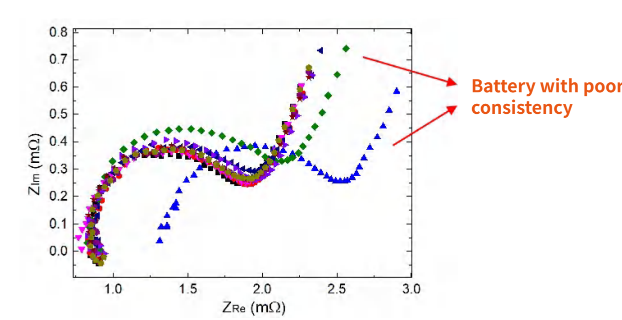


The EIS frequency range can be adjusted according tothe production line pace and process segment

EIS test of LFP battery with Capacity of 280Ah (1500 Hz~0.1 Hz)

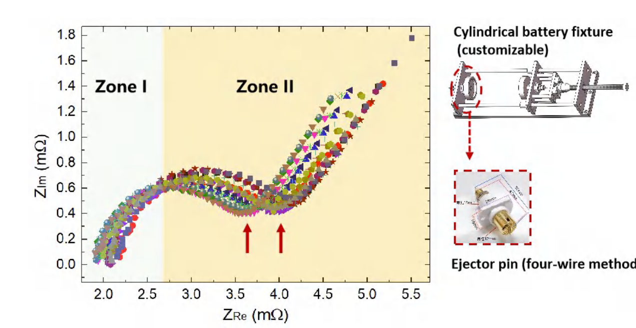


1. EIS screening is conducted on 30 prismatic cells with a capacity of 50Ah each (at 50% state of charge) over a frequency range from 1500Hz to 0.1Hz.



Especially for the battery represented by the green line, its impedance in the high-frequency region is consistent with other batteries, and only the impedance in the medium and low-frequency regions has a large difference. In this case, if only the electronic resistance or 1000Hz impedance is tested, it cannot be effectively distinguished, but swept frequency EIS can effectively screen and identify!

2.EIS screening is conducted on 40 cylindrical cells with a capacity of 30Ah each (at 6.5% state of charge) over a frequency range from 1500Hz to 0.1Hz.



In zone I: For ohmic impedance and SEI impedance, the 30 batteries are distributed relatively concentratedly, with no obvious differences; In zone II: Rct is divided into two concentrated areas, indicating that there are certain differences in the ionic impedance of the 40 batteries, which will affect the capacity after long cycles.

KEY CUSTOMERS

More than 2,000 pcs (sets) of equipments have been provided, serving more than 400 lithium battery users at home and abroad!

Distributed in material companies, battery companies, terminal companies, university research institutes and government testing units

Customers:

CATL	ATL	BYD	Envision AESC	LG Energy Solution	ACC AUTOMOTIVE CELLS Co
CABOT	SK	EcoPro BM	Factorial	Sila	Albemarle
Vianode	CUBERG	AM Batteries	OneD BATTERY SCIENCES	SINTEF	容百科技 RONBAY TECHNOLOGY
Mitra Chem	wisk	VERKOR	CELLFORCE	AMITA Amita Technologies, Inc.	AMARA RAJA Gotta be a better way
HUAWEI	清华大学 Tsinghua University	PowerCo	Hanwha Solutions	IBU tec	NOVO