INNOVATIVE BATTERY TESTING SOLUTION PROVIDER

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IEST 3 Major Business

- Battery R&D Solutions
- Battery Testing Service
- Battery Testing Instruments

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IEST Instruments

DEDICATED TO BATTERY TESTING AND DEVELOPMENT

IEST

PRODUCT CATALOGUE

www.iestbattery.com

Initial Energy Science&Technology(Xiamen) Co., Ltd

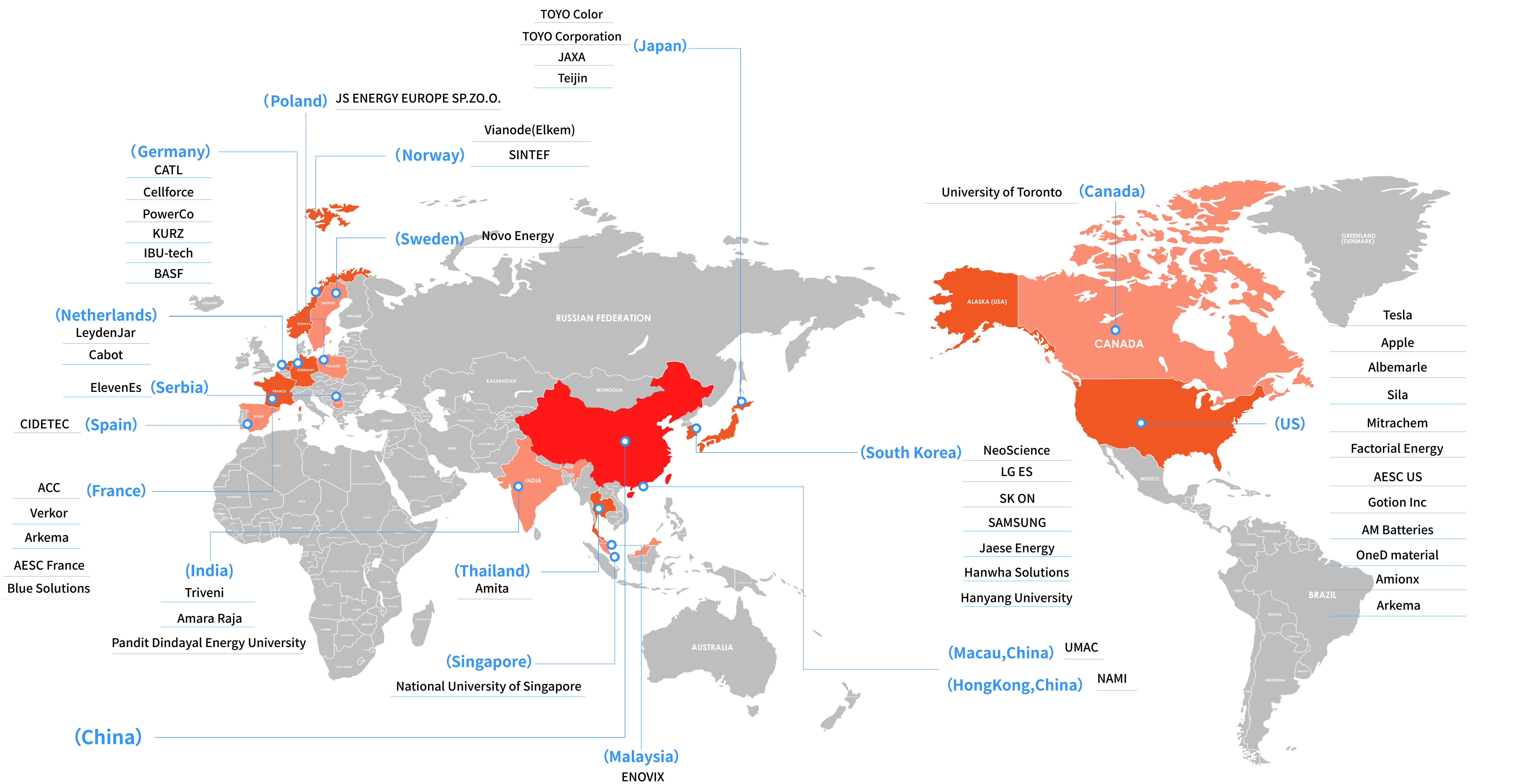
INTRODUCTION

Founded in 2018, Initial Energy Science & Technology Co., Ltd. (IEST) is a comprehensive provider of advanced testing instruments for batteriesLIBs (Lithium-Ion Batteries), SIBs (Sodium-Ion Batteries), and SSBs (Solid-State Batteries)

IEST is committed to delivering top-tier testing instruments with the following testing scope:

- **Anode & Cathode Powders**: Resistivity & Compaction Density;
- **Seperators/Electrolyte**: Tortuosity / McMullin Number / Ionic Conductivity;
- **Anode & Cathode Electrodes**: Resistance, Uniformity;
- **Cells**: In-situ Gassing & Swelling of coin cells, pouch cells, stacked cells, prismatic cells, cylindrical cells;
- **Modules**: Cyclers, CV & EIS testing.

IEST places significant emphasis on the R&D of cutting-edge technologies, and our mission is to enhance our customers' product quality, so as to contribute to the advancement of new energy technologies, and we have supplied over 2,500 instruments to more than 700 clients worldwide.



CATL, ATL, BYD, Envision AESC, LG Energy Solution, ACC, CABOT, SK on, EcoPro BM, Factorial, Sila, ALBEMARLE, Apple, HUAWEI, GS YUASA, TOYOTA, Kanadevia, PowerCo

Vianode, Ingevity, AM BATTERIES, OneD Battery Sciences, SINTEF, 容百科技, Mitra Chem, SAMSUNG, VERKOR, CELLFORCE, AMITA, AMARA RAJA, Hanwha Solutions, IBU tec, NOVO, Tesla, umicore, BASF

CATALOGUE

Material Characterization

In-situ Gassing of Cells

In-situ Swelling of Cells

Electrochemical Characterization

Automation & Intelligence

Single Particle Force Properties Test System

Scan QR code for details

Model Table

Item	Single Particle Force Tester	
Model	SPFT1000	SPFT2000
Applicable Samples	Particle size: 5-50μm(anode & cathode particles, solid electrolyte particles)	
Test Parameters	Force, Displacement	
Test Range	Displacement Range: 0-80μm Force Range: 0-100/500mN	
Test Accuracy	Microscope magnification: up to 1200 times Force Accuracy: ±0.1 /0.5mN Min. Displacement unit: 10nm	
Other Features	Stress-strain Curve Particle Image Observation Automatic Pressure Control High-efficiency Fully Automatic Software	
Automatic XY-axis control	X	√

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Product Introduction

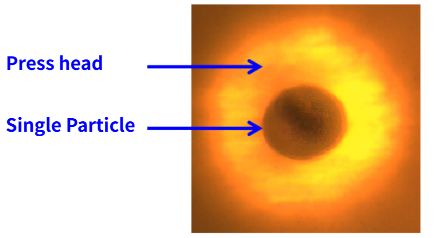
Background: Crushing strength of particles can be used to evaluate the pressure-resistance of the material and guide the rolling process. Materials with higher mechanical strength of particles will exhibit better subsequent cycle stability.

Particle → **Powder** → **Electrode** → **Cell**

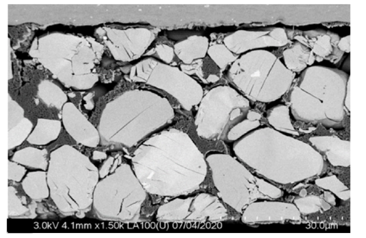
- Particle: Particle-related pressure resistance
- Powder: Powder Compaction density
- Electrode: The stability and consistency of the coating structure
- Cell: Cycle lifespan; Rate performance, etc.

Applicable Samples

1. Cathode: NCM/LCO/LRMs
2. Anode : Silicon-based materials, Hard Carbon, etc.
3. Solid Electrolytes

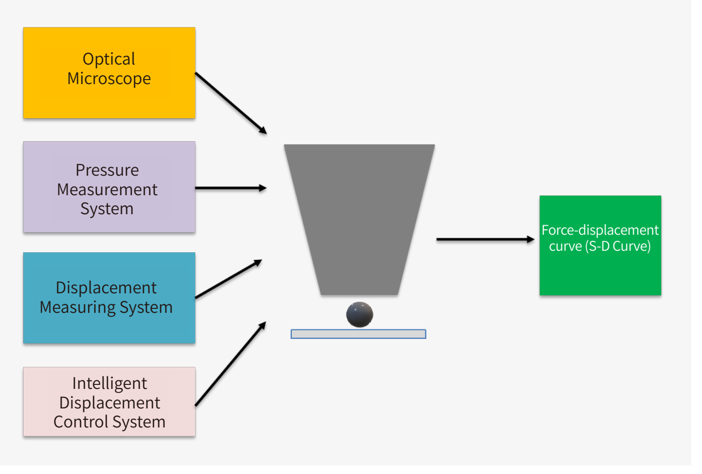


Single Particle Compression (Bottom View)



Particle cracked after cyclic compression (SEM Image)

Equipment Schematic



Basic Functions

To 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

Include displacement, pressure, and software integrated control;
As well as real-time photography and video recording of particles.

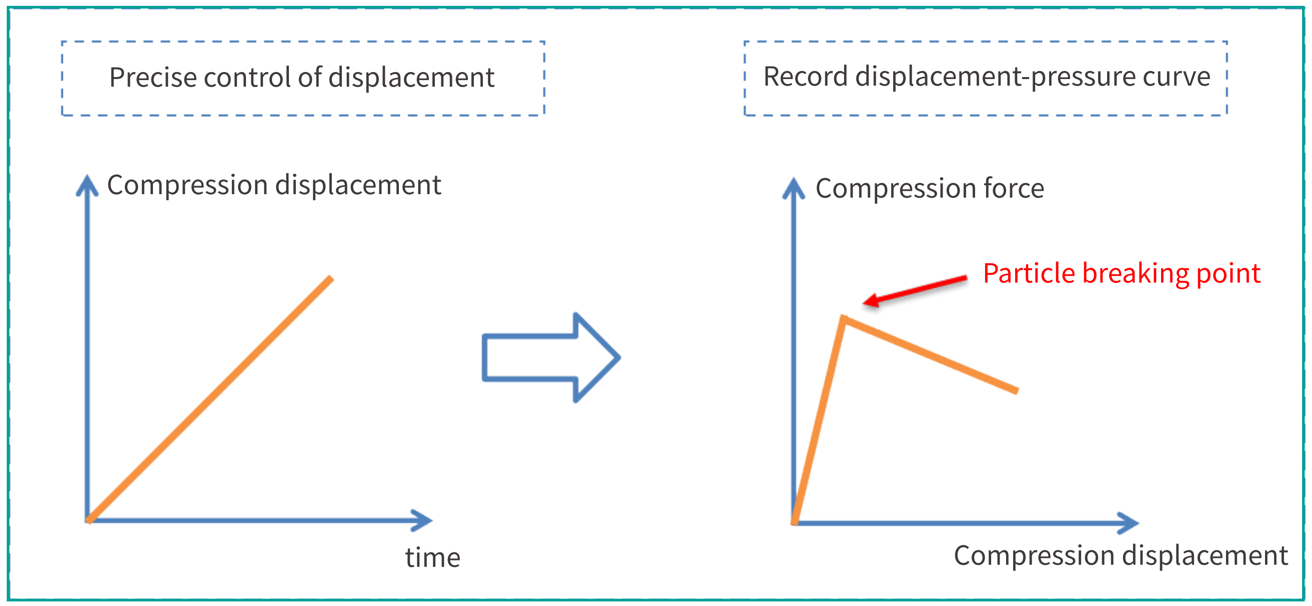
Main Test Steps

Sample Preparation: Disperse the powder evenly into the anhydrous ethanol solution, and then add it dropwise to the glass slide;

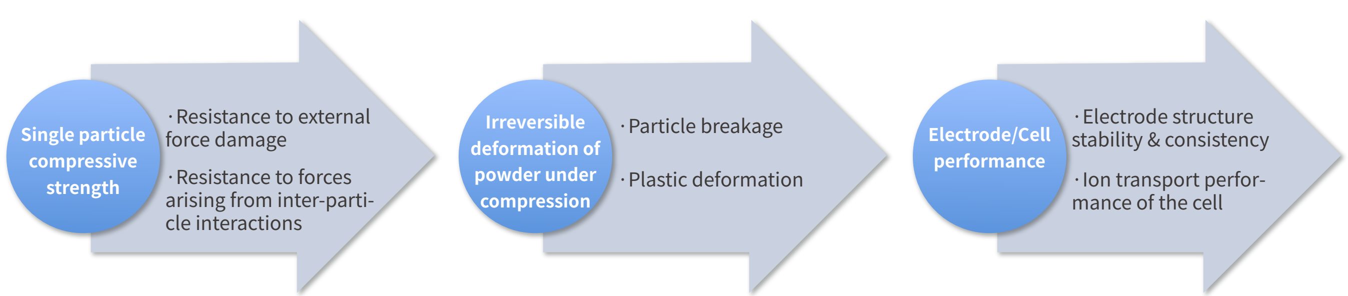
Particle Location: Locate the single particle with the optical microscope;

Particle Compression: Compress the particle at a constant speed;

Data Collection: Collect the force-displacement curves during the compression so as to find the failure point.



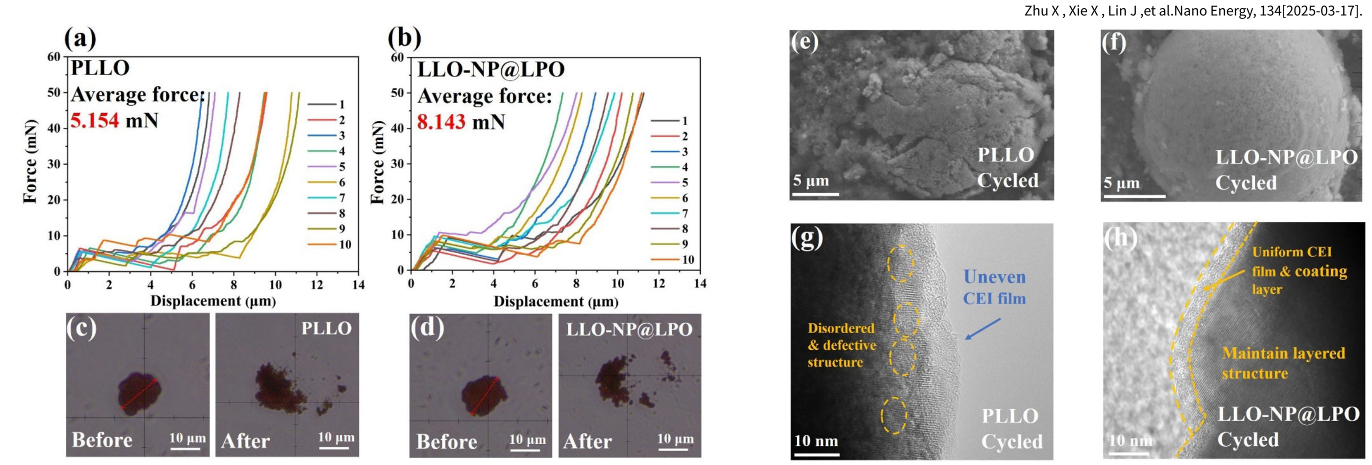
Particle Compression Property and Powder Compaction



Application Cases

Cathode - Lithium-rich Manganese-based Layered Oxides (LLOs)

Zhu X , Xie X , Lin J ,et al.Nano Energy, 134[2025-03-17].

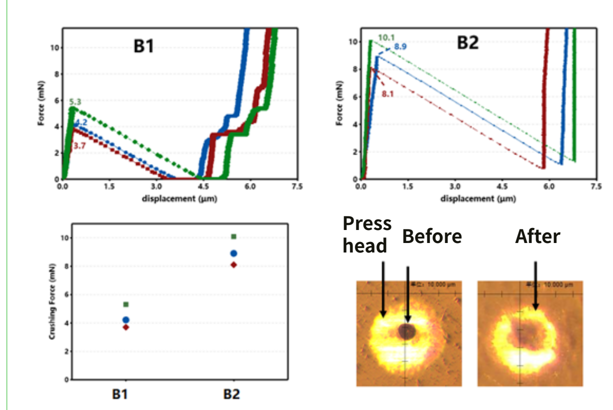


(a) PLLO and (b) LLO-NP@LPO's single particle compression test (c, d) PLLO and LLO-NP@LPO optical photos before and after single particle After being assembled.

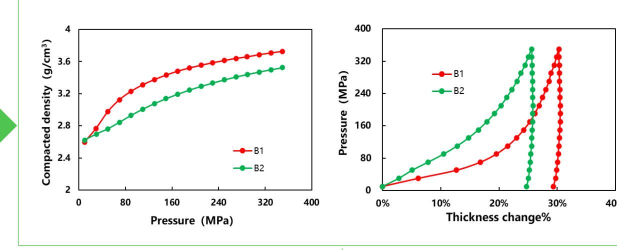
Single-particle compression testing reveals the inherent link between the mechanical properties and electrochemical stability of cathode materials at the micro-scale. It provides direct criteria for evaluating and screening high-performance materials.By using quantitative, high-precision testing methods, we can drive the optimization of surface modification strategies and the construction of battery life prediction models. This forms a crucial bridge connecting material design with practical applications.

Cathode-NCM Material

Single Particle Test

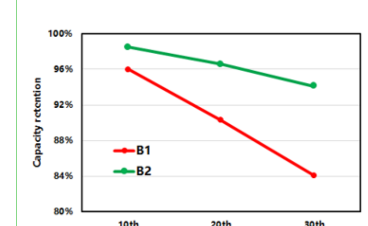


Podwer Test



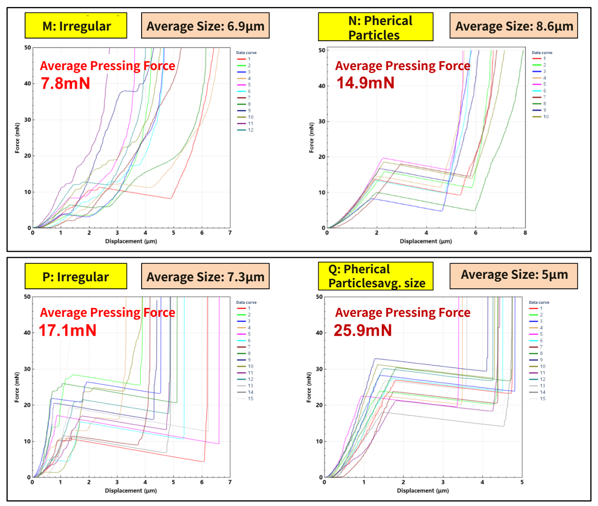
B1 and B2 were sintered from different precursors, with both having a median particle size (D50) of 9.5 μm. However, they exhibited different particle crushing behaviors, resulting in variations in powder compaction and coin cell cycling performance.

Coin Cell Test

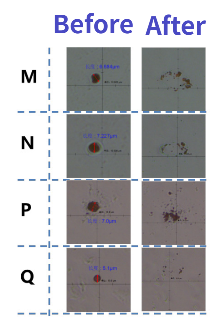


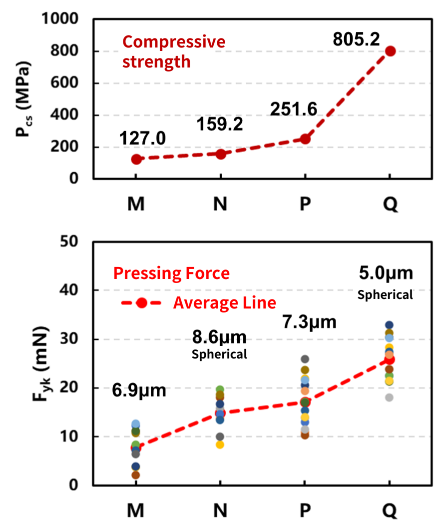
After being assembled into half-cells using the same process, and cycled at 0.5C between 3.0-4.5V at 45°C, sample B2 exhibited better cycling stability.

Anode-Si/C (Different Processes)



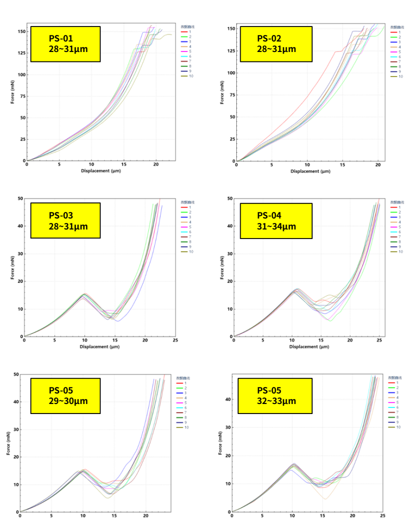
Calculation of compression strength according to the national standard:
GB/T43091-2023 Compression Strength Test Method for Powder.

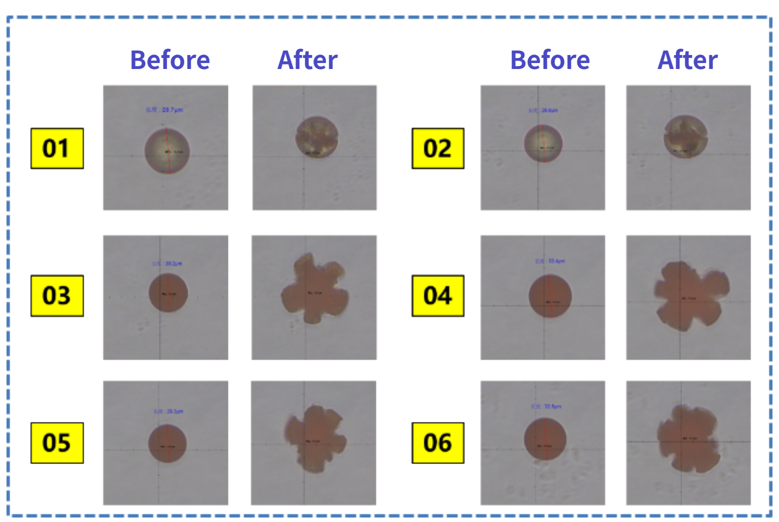




- For spherical particles, the stress and displacement values at the crushing point on the N/Q curve tend to be more pronounced clustering. This likely correlates directly with their morphological uniformity and crystalline structure integrity.
- Although Q has the smallest average particle size, it exhibits the highest average crushing force and compressive strength. (Notably, N, which is the largest and spherical, does not have the highest compressive strength.) This indicates that a particle's compressive strength isn't solely determined by its size and morphology, but is also closely linked to the synthesis process.

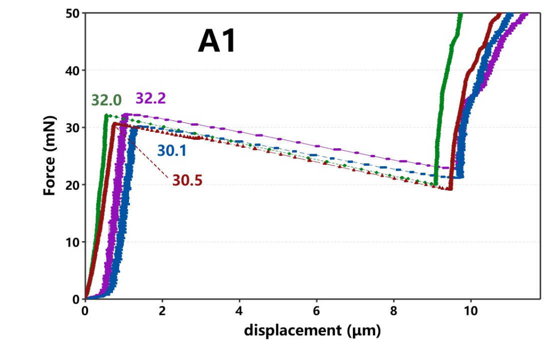
Non-Lithium Battery - Polystyrene Microspheres

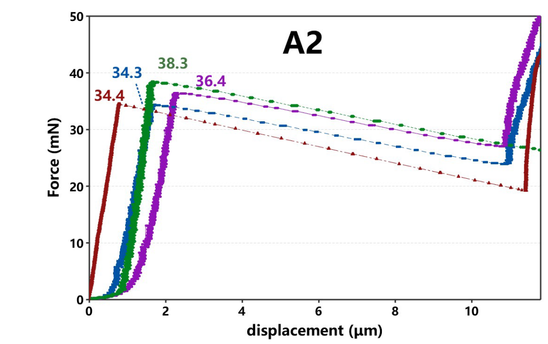


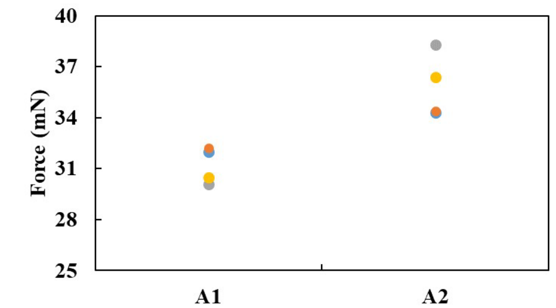


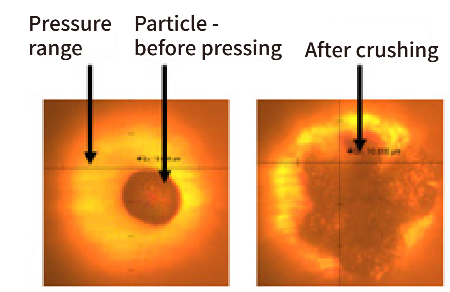
Different types of polystyrene microspheres show significant differences in their compressive properties, deformation mechanisms, and fracture behaviors. These distinct characteristics determine their varied application scenarios.

Application on Cathode Materials——NCM811









The two NCM 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.

Multi-Dimensional Solid-State Electrolyte Testing System

Scan QR code for details

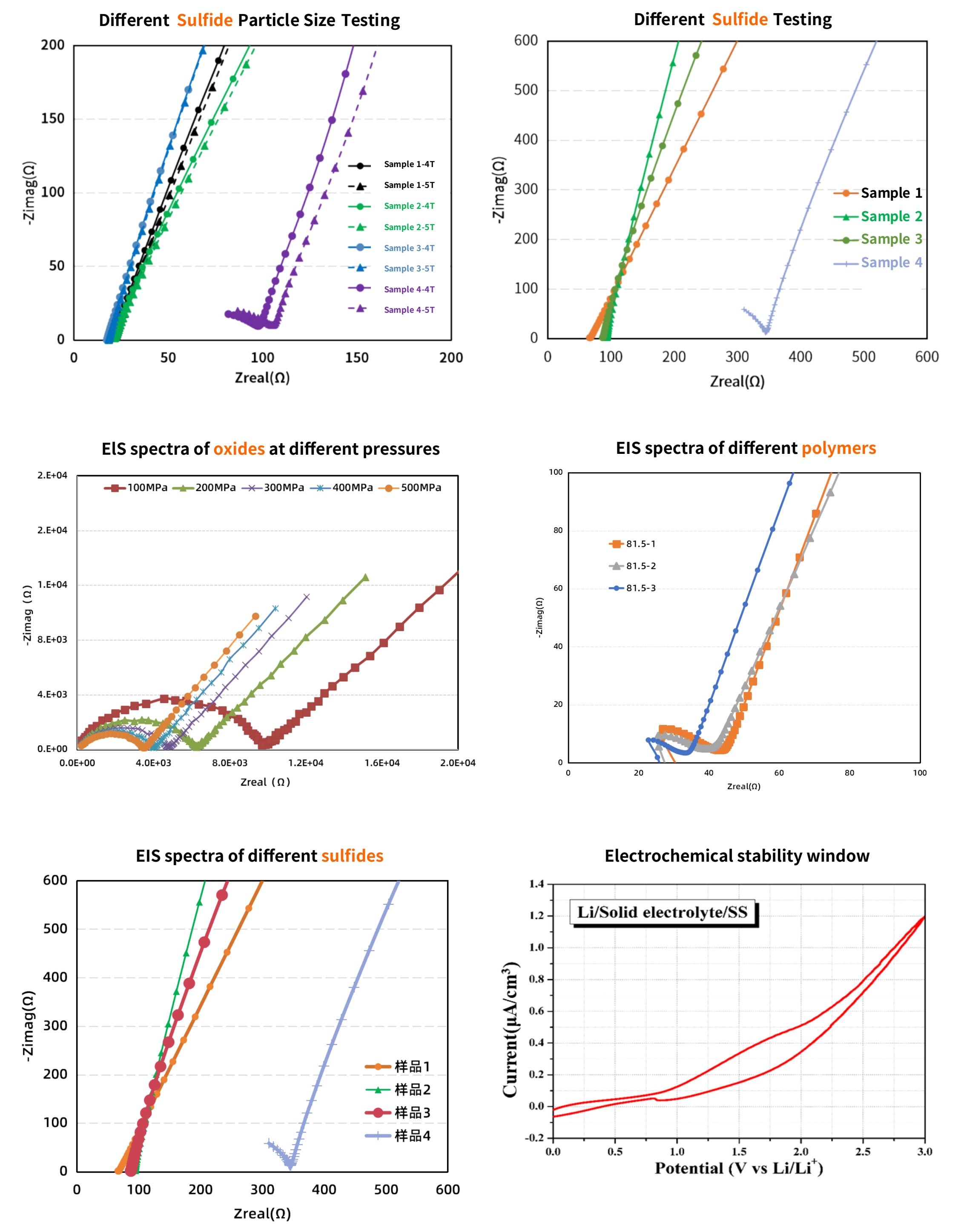
Model Table

Model	SEMS3200	SEMS3100
Pressurization Method	Servo Motor	Hydraulic
Electrochemical Test System	Standard Biologic, customizable for other brands	
Glove Box	√	/
Max. Pressure	≤6T (600MPa)	
Pressure Stability	1%	
Thickness Measurement Accuracy	10μm	
EIS Frequency	≤5MHz	
Sealing Fixture	SCM	
Screw Tightening	Equipped with automatic screw-tightening function	
Test Software	Interconnected with electrochemical workstation, enabling one-click ion conductivity output	Interconnected with electrochemical workstation, enabling one-click ion conductivity output
Equipment Form	Glove Box + Integrated Pressurized Testing Device	Integrated Pressurized Testing Device
Operation	One-click automatic pressurization testing, highly integrated	Separate software operation

Introduction

The Multi Dimensional Solid-State Electrolyte Testing System facilitates comprehensive powder-level material evaluation. It combines atmospheric protection system, pressurization system, pressure measurement system, thickness measurement system, pressing & lock system, electrochemical testing system, integrated with unified software to enable in-situ monitoring of compaction density and electrochemical performance under adjustable pressure and atmospheric conditions.

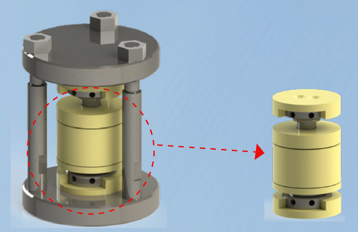
Application Cases



Solid-State Battery Mold & Fixture

Mold & Fixture

The Gas-tight mold’s inner liner is made of ceramic, which can withstand pressure up to 600MPa. Unique insulating cover design ensures structural stability and zero deformation under 60°C high-temperature testing.

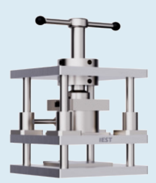
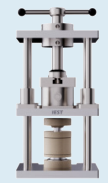


√ Solid-State Electrolyte Ionic Conductivity Test

√ Mold Cell Electrochemical Performance Test

Model	MP1000
Fixture Dimensions	Outer Diameter 70mm，Height 95mm
Standard Mold Dimensions	Inner Diameter 10mm（customizable），Outer Diameter 35mm
Applied Force	Max. 6000kg
Operation Temperature	-10~60°C
Weight	＜10kg
Standard configuration	Fixture+Gas-tight Mold

IEST Cell Clamps for Solid-state Batteries

Model	SWE150P	MPC2000 with 1 jig	MPC1000 with 1 jig
Pictures			
Clamp Material	Stainless Steel	Stainless Steel	Stainless Steel
Clamp Size(L*W*H)	300x200x322 mm	180x120x380mm	100x92x235 mm
Applicable Cells & Size	Pouch Cells with a max size of 240x200x100 mm	Sealed Jig Cells Jig Material: PEEK	Sealed Jig Cells Jig Material: PEEK
Max Mannual Force	Up to 1000 Kg 0.2 MPa	Up to 1000 Kg Jig1:10mm(124.8MPa) Jig2:13mm(73.8MPa)	Up to 400 Kg Jig 1: 10mm(49.9 MPa) Jig 2: 13mm(29.5 MPa)
Force Sensor Range	3000 Kg	3000 Kg	2000 Kg
Force Sensor Accuracy	0.3% F.S	0.3% F.S	
Clamp Weight	35 kg	16	3
Working Temp	-10~60°C	-10~60°C	-10~60°C
Descriptions	These clamps are designed for detecting the swelling force of liquid & solid-state pouch cells under constant gap during cycling. Together with an additional Force Acquisition Console and Cyclers, it can automatically collect the swelling force during cycling.	These clamps are designed for testing of the swelling force of the solid-state jig cells under constant gap, Together with an additional potentiostat, it can be used to test EIS of the sulphides solid elecrtrolytes. Note: additional glove box needed for assembly of the solid-state jig cells.	

Solid-State Battery Mold & Fixture

Introduction

With a maximum pressing force of 10,000 kg, the system allows for freely adjustable pressurization force and pressure holding time. Triaxial simultaneous screw tightening post-pressure application, eliminating uneven pressure distribution caused by manual handling.

Automatic Pressing Locking Machine APLM

Characteristics

- Pressure range: 0-10 tons, customizable based on mold dimensions
- Simultaneously lock/unlock screws during pressure holding to enhance operational efficiency
- Precisely control screw torque to ensure balanced triaxial pressure and torque

Model Table

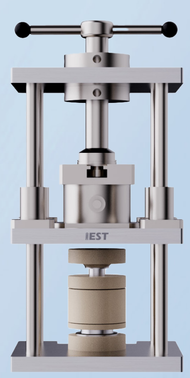
Model	APLM
Pressure Range	500kg~10000kg
Pressurization Method	Servo motor / Electric-hydraulic (optional)
Equipment Dimensions	500*400*1000mm
Pressure Control Accuracy	Servo motor：±0.3% F.S.，Electric-hydraulic：±1% F.S.
Platen Parallelism	OK
Screw Tightening	√
Locking Method	Simultaneous Triaxial Tightening
Screw Removal Function	√

Solid Electrolyte Measurement System

Scan QR code for details

Creative Solutions

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



MPC1000

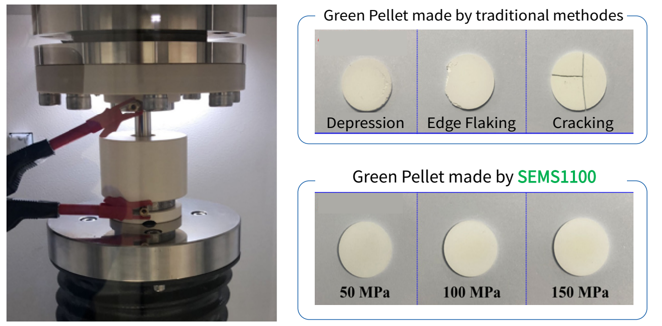
SWE150P-S

SEMS1100

Application Cases

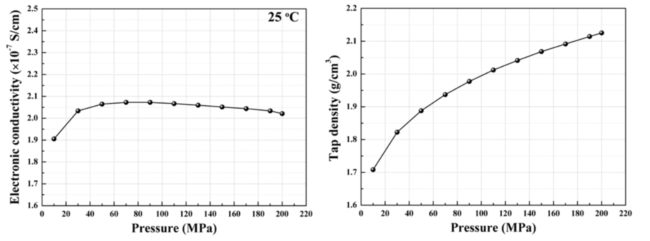
Green Pellet Formation

The equipment enables the preparation of green pellets for solid-state batteries.



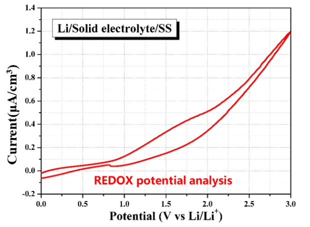
Electronic conductivity & compaction density

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



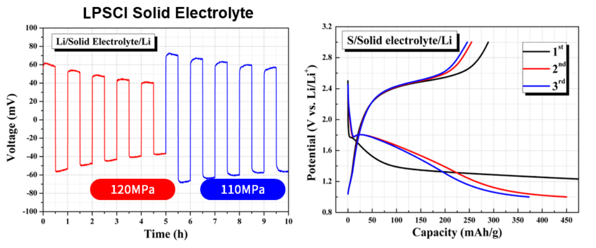
Electrochemical stabilization window

The cyclic voltammetry (CV) module enables analysis of the electrochemical stability window for solid-state electrolytes under varying pressure conditions .



Solid-state battery cycling performance

The charge-discharge (CD) module facilitates evaluation of electrochemical cycling performance of solid-state lithium metal batteries, with differential parameters.



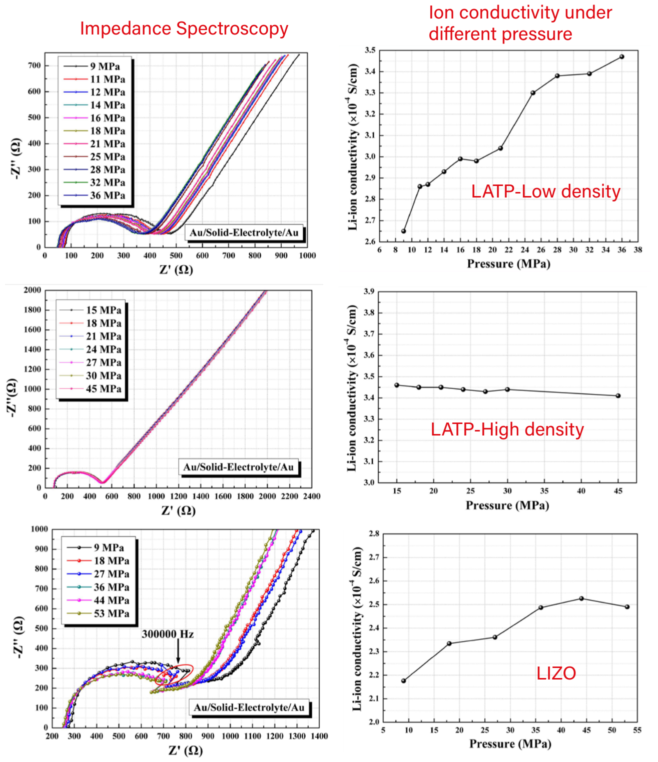
Stability of Li/SE/Li interface under different pressures

All-solid lithium metal battery

Ionic conductivity

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

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



Battery Slurry Resistance Analyzer

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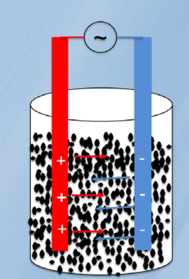
for details

Slurry Resistivity Test Principle



Test Methods: Fill the measuring glass with ~80mL of slurry, insert clean electrodes, and record resistivity over time using three pairs of electrodes.

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): $\rho_e = \frac{U}{I} \times \frac{S}{l}$

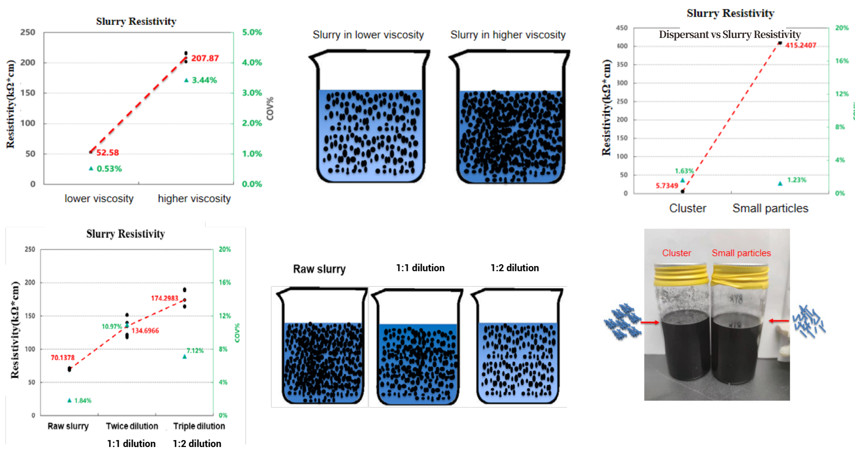
Specifications

Product model	BSR2300		
Resistivity range	2.5Ω*cm~50MΩ*cm	Resistivity accuracy/resolution	±5%/0.01Ω*cm
Conductivity range	0.02μS/cm~400mS/cm		
Temperature range	0~40°C	Temperature accuracy/resolution	±0.5°C/0.1°C
Number of test electrodes	three pairs		

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Application Cases

Evaluation of conductive agent slurry with different formulations

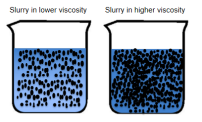


When the viscosity, concentration and dispersant type of the conductive agent are changed, the resistivity also changes!

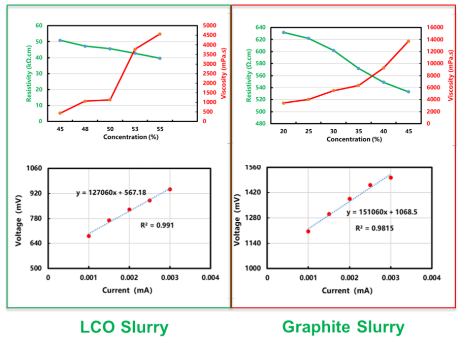
In the future, specifications can be formulated for the slurry resistivity of a certain fixed viscosity, and the stability of the slurry process can be monitored!

Concentration-viscosity-resistivity correlation

Slurry formula



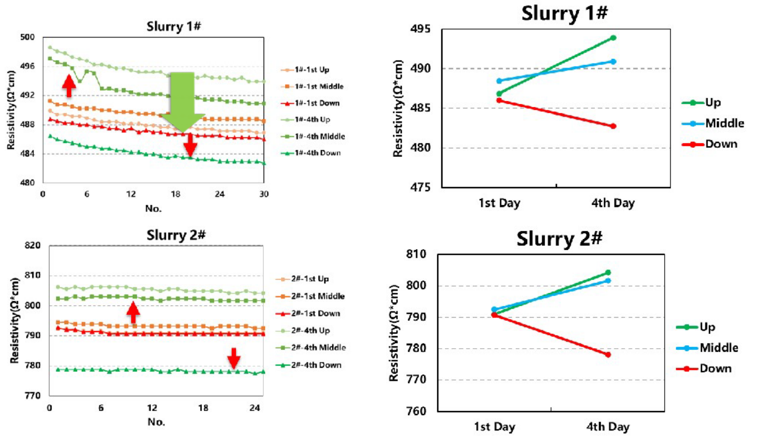
Graphite	SP	CMC	SBR
96.5	0.5	1.5	1.5
LCO	SP	CNT	PVDF
94.0	2.0	1.0	3.0

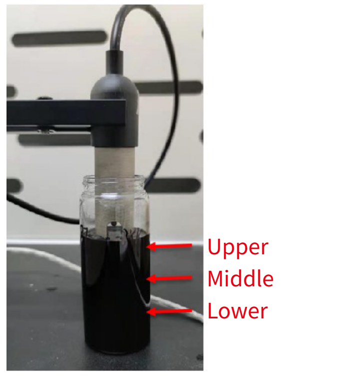


The resistivity of the slurry decreases with the increase of the concentration, and the change of the viscosity is also inversely proportional to the relationship;

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;

Slurry settling performance





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

Model Table

Model	BER2300	BER2500
Pressure method	Servo motor	
Resistance range & accuracy	1μΩ~3.1kΩ (±0.5% F.S.)	
Pressure range & accuracy	up to 1000kg——5~60MPa (±0.3% F.S.)	
Thickness range	/	0~5mm
Thickness resolution & accuracy	/	0.1μm/±1μm
Testable parameters	Resistance, resistivity, conductivity, pressure, temperature and humidity	Resistance, resistivity, conductivity, pressure, temperature and humidity, thickness, compaction density
Features	Single point test mode; Continuous test mode; Variable pressure mode	

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Testing Methodology and Principles

Test parameters: The BER series battery electrode resistance analyzer employs a dual-plane pressure-controlled 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. **Pressure Range**: 5~60MPa
2. **Test Range**: 0~5mm
3. **Test Accuracy**: ±1μm

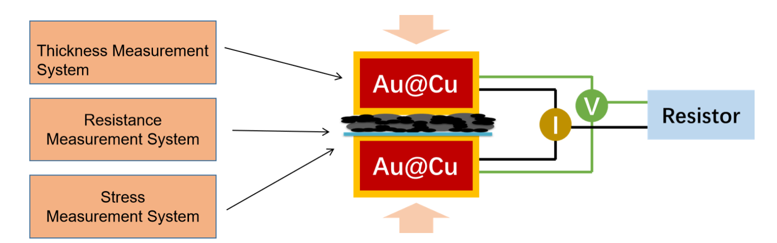
Calculation formula

Compaction Density(g/cm³): $D = \frac{m_{\text{Area density}}}{L_{\text{Coating Thickness}}}$

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

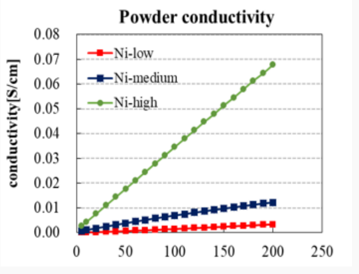
Conductivity (S/m): $\sigma_e = \frac{1}{\rho} = \frac{l}{RS}$

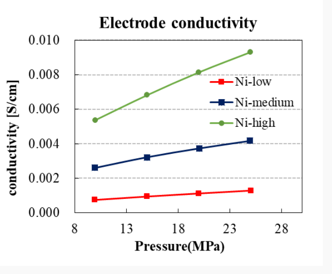
Gold-plated copper with a plating thickness: 1 μm



Appliction Case - Material Evaluation

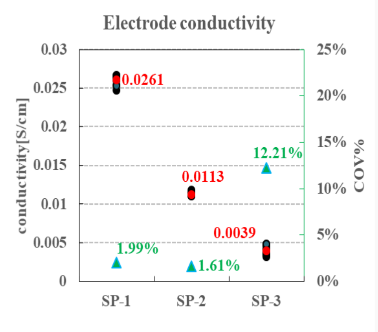
Material evaluation: correlation between powder conductivity and Electrode conductivity





Conclusion: The powder conductivity and electrode conductivity have the same trend!

Conductivity evaluation of conductive agents



Constant pressure test

Pressure: 25MPa

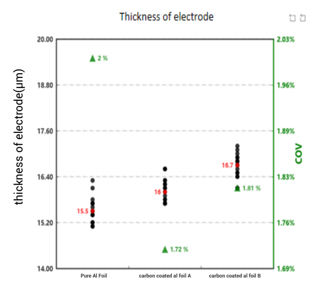
Holding time: 25s

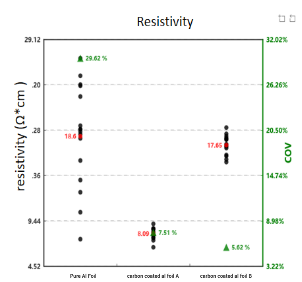
Points tested: 15points.

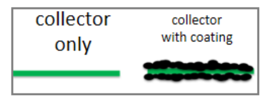
Conclusion: Electrode conductivity characterization can be used to evaluate the conductivity and dispersion performance of conductive agents!

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

Evaluation of primer coated aluminum foil: pure aluminum foil, carbon coated aluminum foil A, carbon coated aluminum foil B







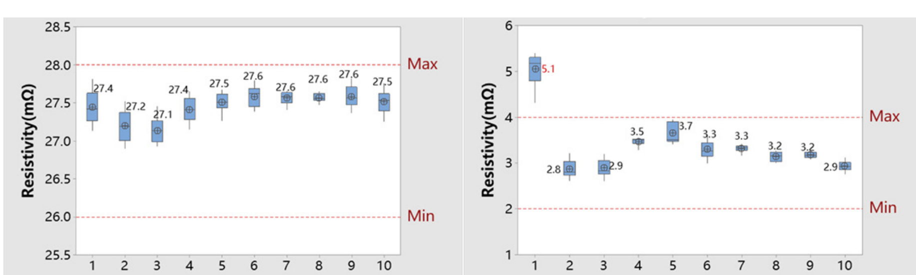
Constant pressure test:
Pressure: 25MPa
Holding time: 15s
Points tested: 10 points.

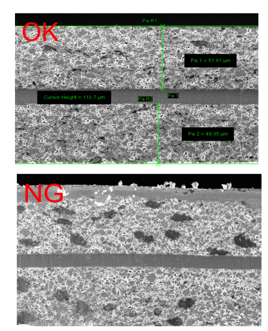
Conclusion

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

Application Case - Process Evaluation

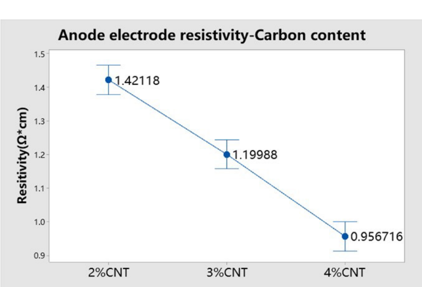
Uniformity evaluation for the distribution of conductive agent





Conclusion: The quality of the first batch of the 10 anode electrodes is not acceptable as its resistivity is outside the normal range.

Anode and cathode electrodes with different conductive agents



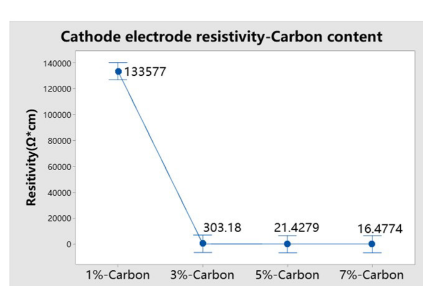
Analysis of Variance

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			

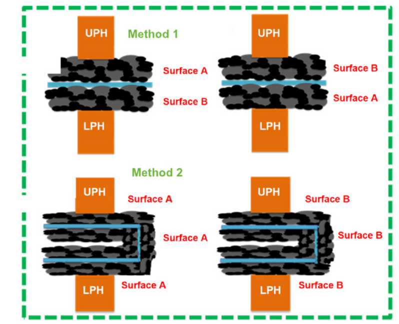
Means

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)

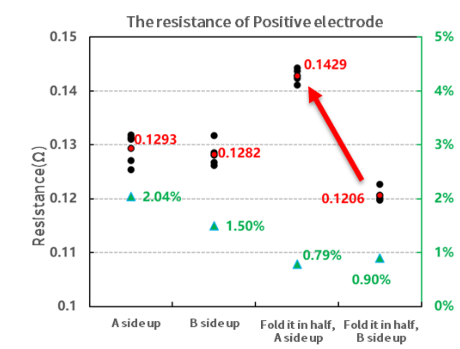
Pooled StDev = 7921.77

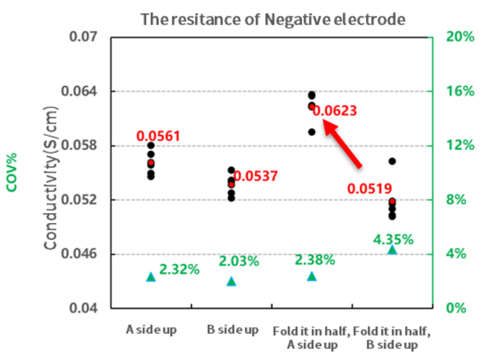
Conclusion: The resistivity of the NCM electrodes decreases with the increase of Carbon content, and when the content is greater than 5%, the resistivity decreases slightly.

Separate the resistivity of the A side and B side coating layers for the double-coating electrode



UPH/LPH: Upper/Lower Press Head





M1: $R_{Total} = R_{UPH\text{-}A} + R_A + R_{A\text{-}foil} + R_{foil} + R_B + R_{B\text{-}foil} + R_{B\text{-}LPH}$

M2: $R_{Total} = R_{UPH\text{-}A} + 2R_A + 2R_{A\text{-}foil} + R_{foil} + R_{A\text{-}LPH}$

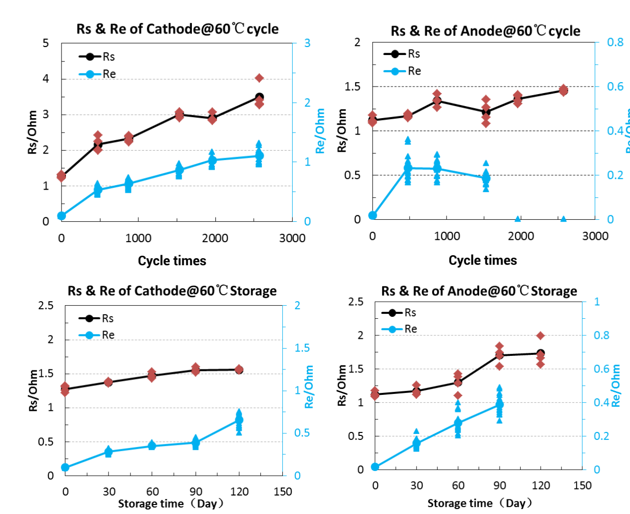
Constant pressure test
Pressure: 25MPa
Holding time: 15s
Points tested: 5 points for each group.

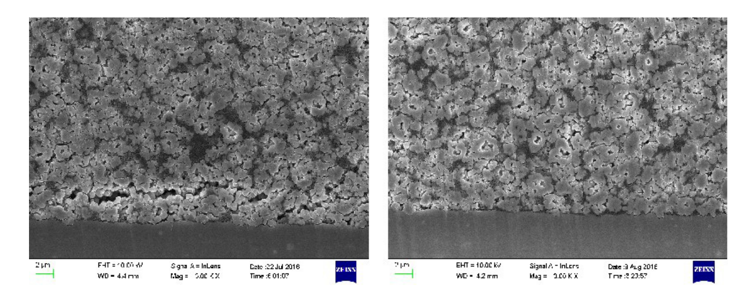
Conclusion

1. When the A side or the B side is facing up alone, the difference in the resistance and uniformity of the electrode sheet is small;
2. The 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;

Application Case - Failure Analysis

Analysis of electrode resistance during high temperature cycle&storage





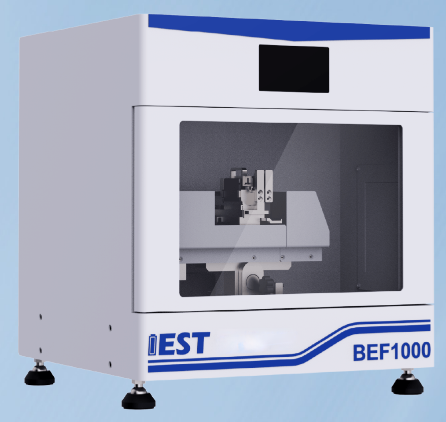
The resistance of the cathode continues to increase with the increase of the cycle numbers, indicating that a large change has taken place on the cathode side after the high temperature cycle, which may be related to the byproducts on the surface of the cathode particles or the contact between the particles;

Conclusion

1. The resistance of **cathode** electrodes increases with the number of **cycles**.
2. The resistance of **anode** electrodes increases with the **storage time**.

Battery Electrode Flexibility Testing System

Scan QR code
for details



Model Table

Model	BEF1000	
Equipment Parameters	Pressure Test Range	0~10000mN
	Pressure Resolution	±0.01mN
	Pressure Accuracy	±10mN
	Displacement Travel Range	0~18mm
	Displacement Accuracy	±10μm
	Displacement Resolution	0.1μm
	Sampling Frequency	10Hz

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Flexibility Testing of Electrode Sheets

- Enhance battery performance and consistency
- Optimize manufacturing processes, improving production efficiency and first-pass yield
- Ensure battery safety and reliability
- Support the R&D of new materials and processes
- Meet industry standards and market demands

Systematic flexibility testing enables comprehensive optimization of electrode sheet performance, driving advancements in battery technology and providing crucial support for the growth of the new energy industry.

Evaluation of material formulations

Optimisation of production process

Product quality control

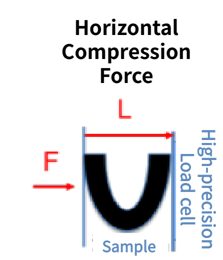
Adapting to new battery designs

Innovative Solution

The BEF1000 Electrode Flexibility Testing Equipment adopts the fundamental testing method for electrode stress-strain curves: after bending the electrode at a specific angle and mounting it on the testing device, displacement is applied to induce deformation, and the stress and strain (stress-displacement relationship) of the electrode under different deformation degrees are measured to evaluate its flexibility.

Equipment Functions

- Cyclic Testing: Enables single-pressure application or multiple reciprocating tests.
- Inspection: Equipped with third-party calibrated standard thickness blocks and weights for regular equipment spot checks.



Displacement Force Precision Testing

Precise displacement control, combined with high-precision pressure sensors, Real-time recording of displacement pressure curves

Flip mechanism Bi-directional testing

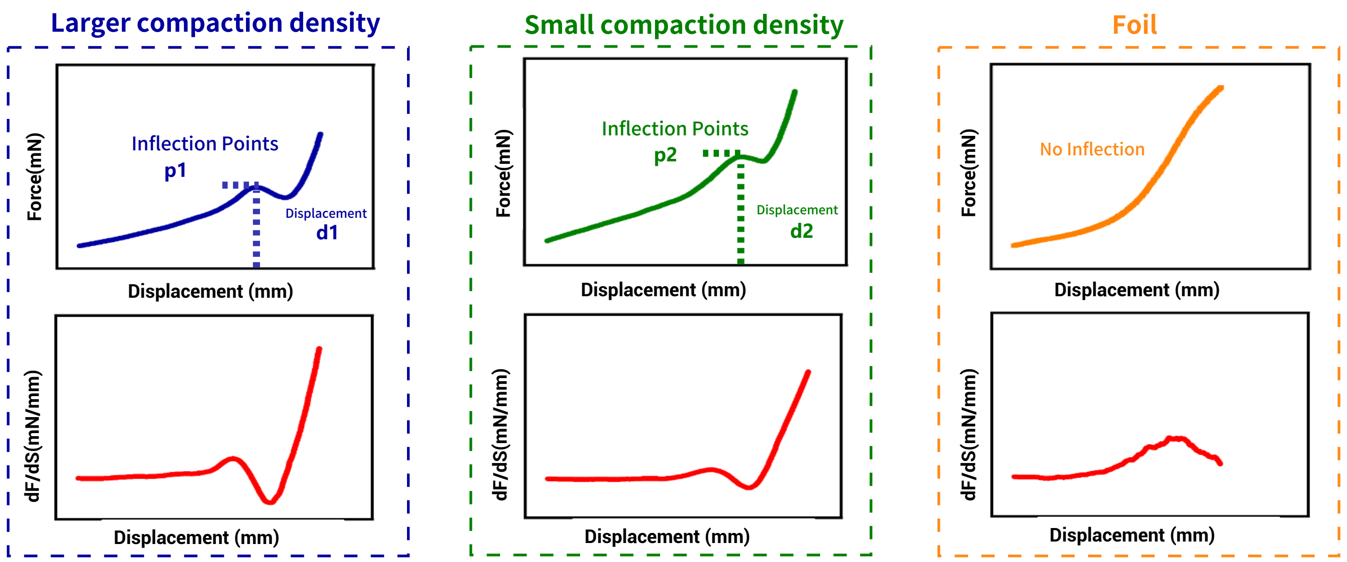
The test meachaism is capable of rotated 90°, supporting horizontal pressing and vertical pressing. testing scenarios.

Detachable Electrode fixture

Ensures consistent clamping of the electrodes, prevents twisting damage to the electrodes, Facilitates operation for testing personnel.

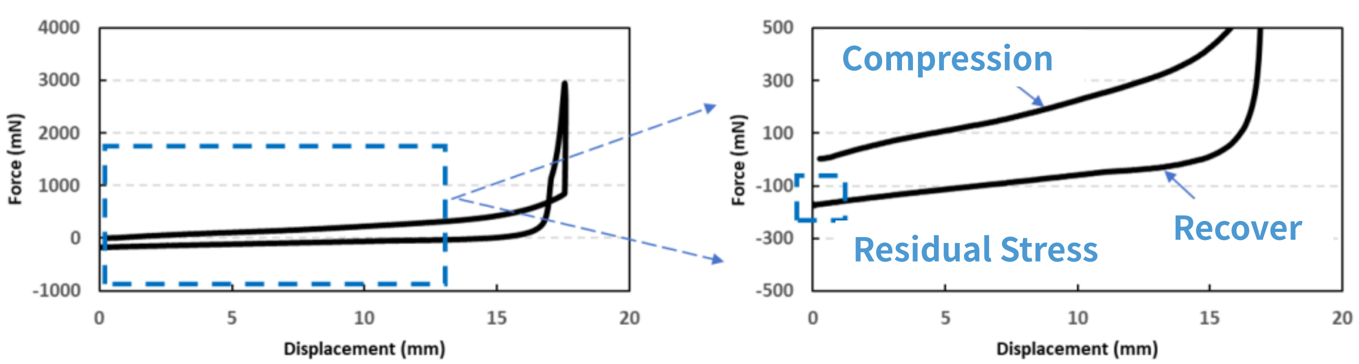
Methods of Analysis

Bendability



- **Analyze fracture point**: Electrode with larger compressive displacement corresponding to the better flexibility.
- **Curve Shape**: Higher flexibility may have smoother curves.
- **The first derivative**: Electrode sheets with poorer flexibility may show larger peaks or sharp changes.

Recoverability

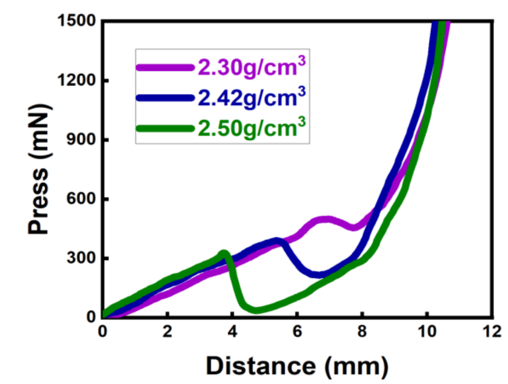


- **Curve Shape**: The stress- strain curve has no obvious inflection points, and for electrode sheets with higher flexibility, the absolute value of their residual stress is smaller.
- **Fatigue Test**: Evaluate the recovery ability and long-term stability after deformation during multiple bending processes by analyzing residual stress.

Application Cases

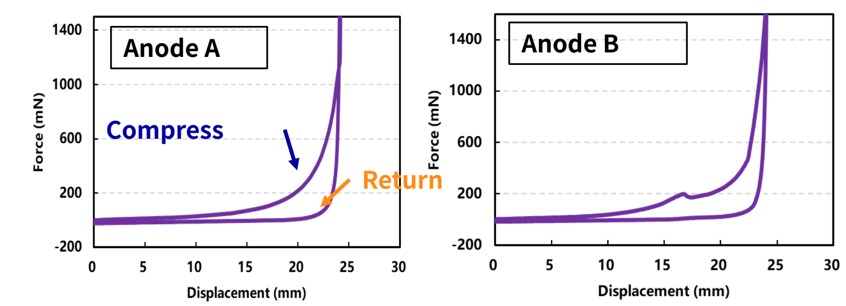
Anode & Cathode Electrode

- **2 LFP electrode sheets with different compaction densities**



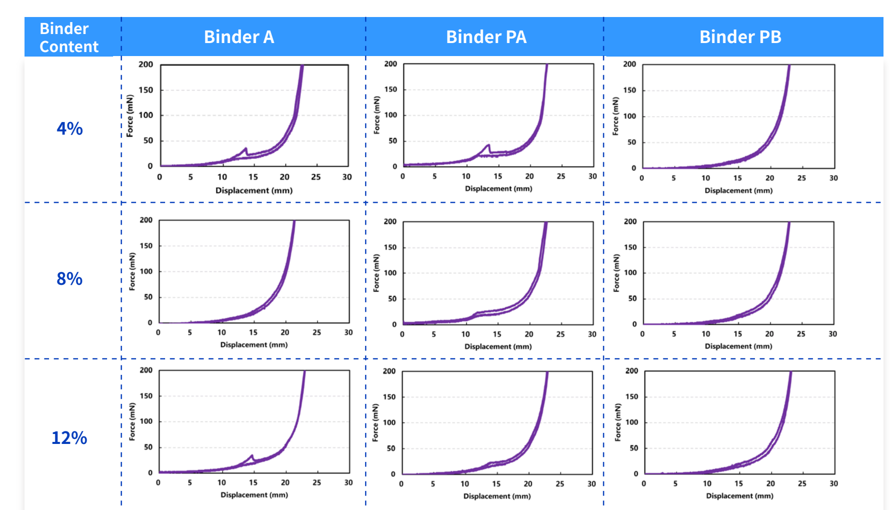
- Three groups of electrode sheets with different compacted densities underwent compression testing.
- As the compacted density increased, the compressive fracture stress and corresponding displacement both decreased, indicating progressive deterioration of flexibility.

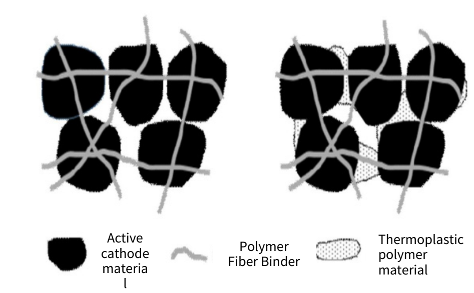
- **Different Hard Carbon Anode Electrode Sheets A/B**



- Compression and decompression cyclic experiments were conducted on two sets of electrode sheets to compare their flexibility.
- An inflection point appeared in the curve for Electrode B, indicating a clear stress decay process, suggesting that B has slightly poorer flexibility than A.

Fibrous Binder





- Evaluating the impact of varying binder types in the electrode sheets to evaluate their flexibility during compression.
- At the same content, the flexibility of binders A and PA is inferior to that of PB; and an 8% content might be a relatively suitable proportion for all three types of binders.

Electrode Ionic Conductivity Tester

Scan QR code for details

Model Table

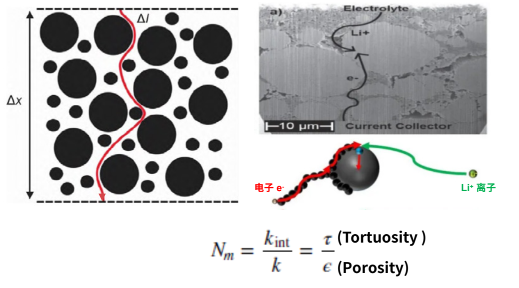
Model	EIC2400M	EIC2400M-T
Channel	4	
Atomesphere	Automatic gas exchange ensures high-purity Argon environment in the chamber	
Temp. Control	/	-20-80°C
EIS range	100k~0.01 Hz	
Force range	10~50kg	
Pressure range	0.5-2.5MPa (16mm indenter)	
Applicable Sample	Cathode/anode (18mm discs), Separator (26mm discs)	
Mold dimension	Φ45*20.5mm (W×H)	
Test parameters	Air pressure, dew point, ionic conductivity, MacMullin number, etc.	
Features	• Automatic gas exchange, high-purity Argon environment; • Automatic electrolyte injection; • Multi-channel rapid assembly, EIS spectrum testing; • EIS curve fitting for ionic conductivity and MacMullin number;	• Independent temperature control for each channel (EIC2400M-T only);
Instrument Dimension	590*590*1100mm (W×D×H)	722*589*1193mm (W×D×H)

Significance

Electrode Tortuosity & Kinetic Performance

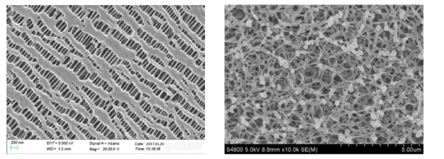
Tortuosity: Quantifies pore path curvature in porous electrodes, directly impacting electrolyte percolation and ion transport efficiency.

Performance Link: Enables rapid correlation between electrode microstructure and electrochemical behavior (e.g., rate capability, capacity utilization)



Separator Ionic Conductivity

Critical for balancing safety (enhanced by coatings) and electrochemical performance in coated separators

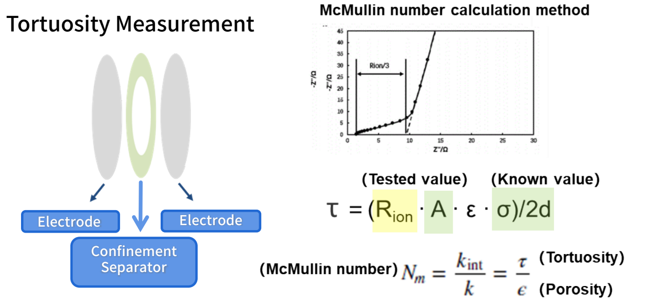


Membrane pores with different preparation processes

Testing&Calculation Methods

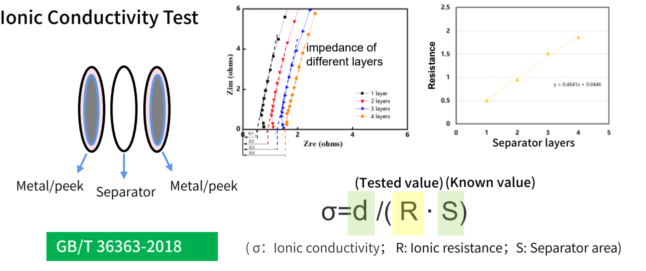
Electrode Sheet Testing

- Assemble symmetric cells and perform EIS testing.
- As shown in the right figure, perform linear fitting on the high-frequency and low-frequency regions of the EIS spectrum, respectively. The difference between the intercepts of the two fitted curves with the X-axis, multiplied by 2, gives the ionic resistance Rion of the electrode coating.
- Calculate the MacMullin number using the formula, thereby indirectly characterizing the tortuosity of the electrode sheet.



Separator Testing

- Measure the impedance of 1-4 layers of separator to obtain R1, R2, R3, and R4.
- Plot the separator layer number on the horizontal axis and the separator resistance on the vertical axis. Determine the slope and linear goodness-of-fit of the curve; the linear goodness-of-fit should be ⩾ 0.99.
- Calculate the ionic conductivity according to the formula.



Creative Solution

- Measure the impedance of 1-4 layers of separator to obtain R1, R2, R3, and R4.
- Plot the separator layer number on the horizontal axis and the separator resistance on the vertical axis. Determine the slope and linear goodness-of-fit of the curve; the linear goodness-of-fit should be ⩾ 0.99.
- Calculate the ionic conductivity according to the formula.

Integrated three major systems:

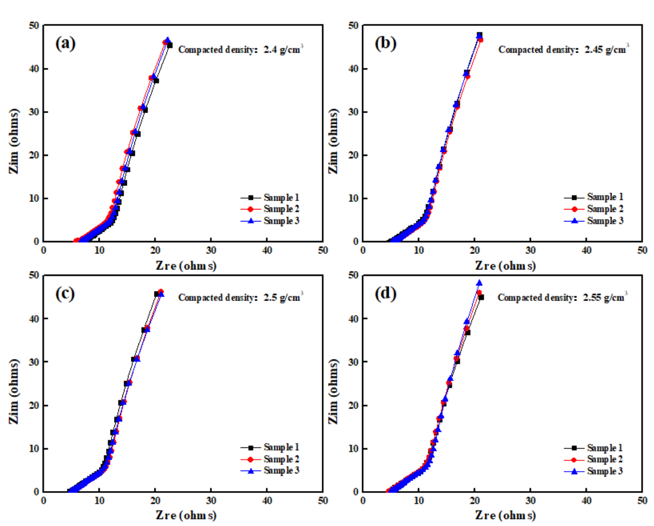
- Automatic gas exchange system
- Automatic liquid injection system
- EIS testing system

Product Features

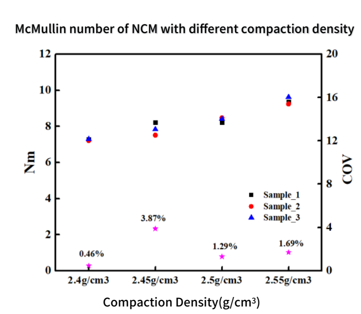
- High-purity argon atmosphere
- Simple assembly
- Automated testing and analysis
- Four-channel synchronous testing
- Rapid EIS testing module

Application Cases

EIS of NCM with different compaction density



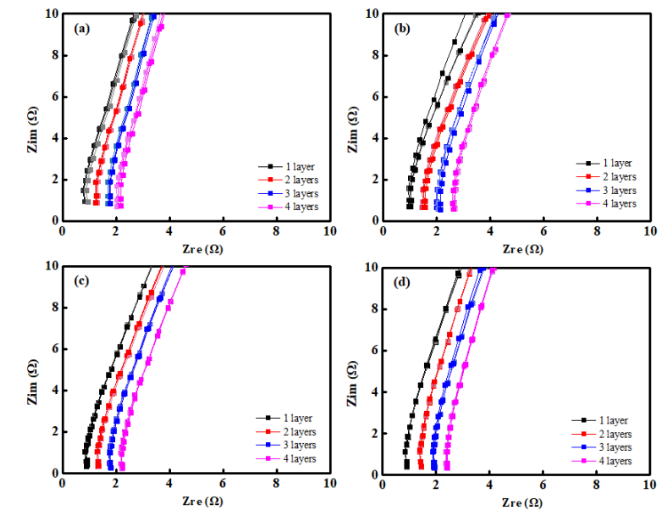
$$Nm = (R_{ion} \cdot A \cdot \sigma)/2d$$



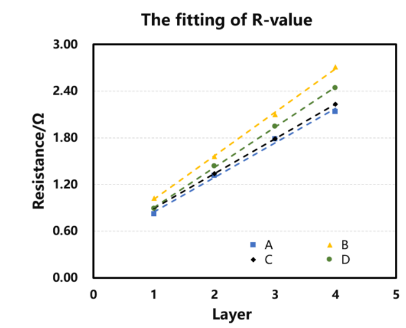
Conclusion

1. The EIS results of the symmetric cells show good overall consistency.
2. The ionic resistance/McMullin number increases with the increase of compaction density within a certain range.

Anode & Cathode Electrode



Ionic conductivity of separators with four different coatings



Separator	The fitting formula
A	y = 0.44x + 0.41
B	y = 0.56x + 0.45
C	y = 0.45x + 0.45
D	y = 0.52x + 0.39

Separator	σ/ S/cm
A	0.00112
B	0.00169
C	0.00189
D	0.00145

σ=d/(R*S)

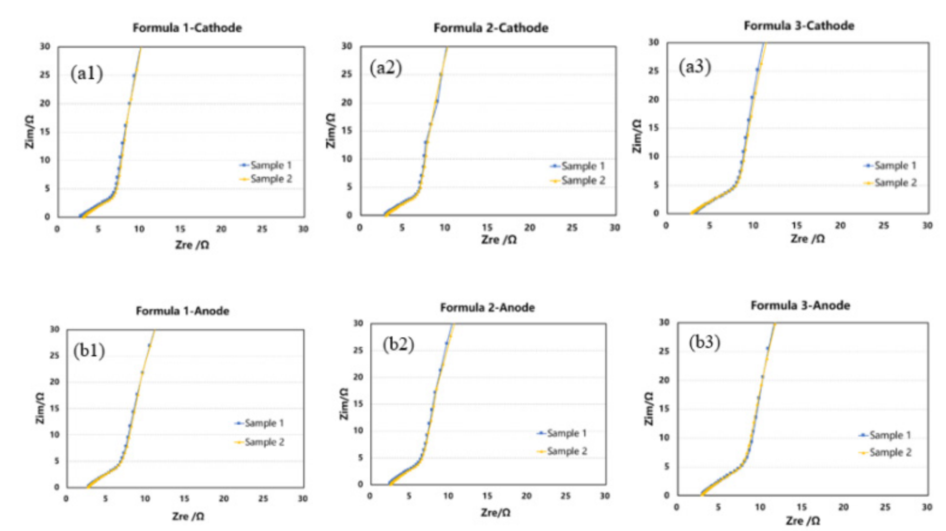
σ: Ionic conductivity
d: Separator thickness
R: single-layer Separator resistance

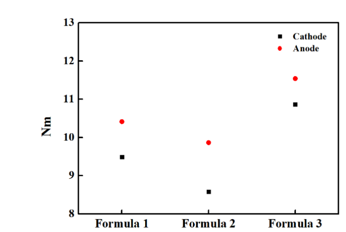
Conclusion

1. The linear fitting degree of the 4 groups of separators resistance tested is ⩾99%.
2. There is a clear distinction between different membranes.

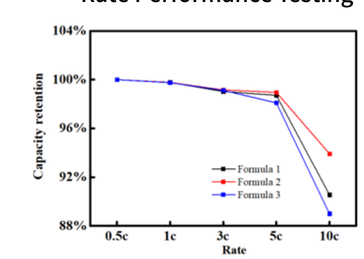
Correlation between Electrode Tortuosity and Electrochemical Performance in Different Electrolytes

Testing of Electrode Tortuosity in Different Electrolytes



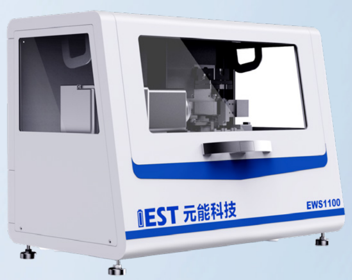


Rate Performance Testing



- The trend of MacMullin number for both positive and negative electrodes in different electrolytes is: Formulation 3 > Formulation 1 > Formulation 2.
- When the rate is 10C, the capacity retention rate of Formulation 3 is the lowest, at only 89%.
- Different electrolyte formulations affect the ease of lithium-ion migration within the electrode. A higher MacMullin number indicates greater resistance to lithium-ion migration, resulting in poorer battery rate performance.

Electrolyte Wetting Solutions

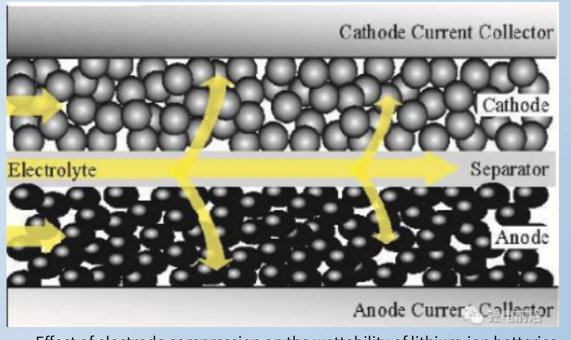


EWS Series

ETS Series

CHT Series

Principle



Effect of electrode compression on the wettability of lithium-ion batteries
DOI: 10.1016/j.jpowsour.2014.04.127

$$h^2 = \frac{cr\sigma cos\theta}{2\eta}t$$

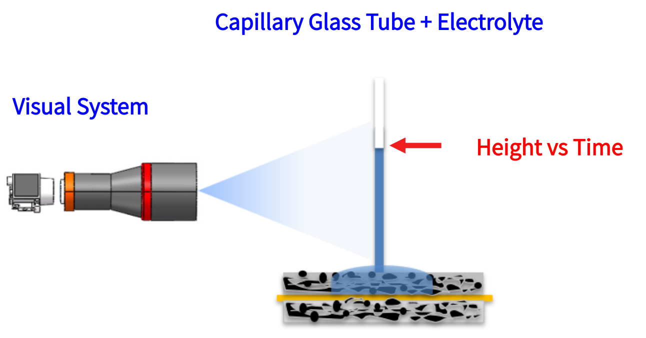
For Unidirectional capillary penetration, the Lucas-Washburn equation is the fundamental relation that has been used to describe the absorption, as shown in the formula, where:

- r represents the radius of the capillary (m),
- σ represents the surface tension of the imbibition fluid (N/m),
- η represents the viscosity of the imbibition fluid (Pa*s),
- θ represents the contact angle of the wet phase (°),
- h represents the liquid suction height (m),
- t represents the liquid suction time,
- cr represents a fixed value, called the formal radius.

EWS - Capilary Wetting Solution

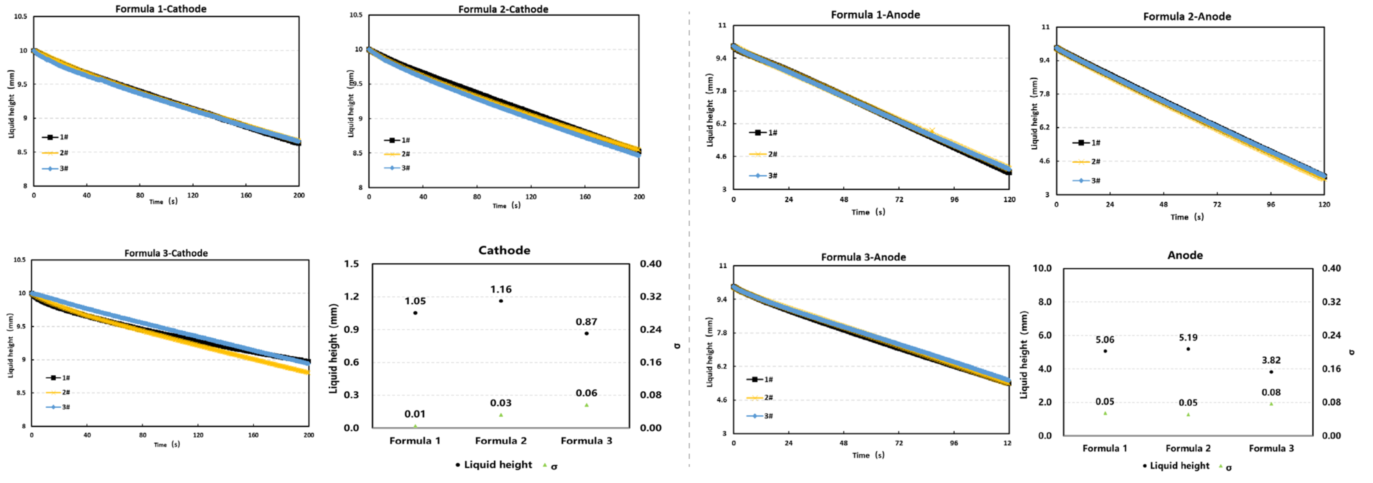
Features

- High-precision vision inspection system.
- In-situ & real-time characterization of electrolyte wetting rate of the anode electrodes.
- Applicable samples: Anode electrodes.
- Higher electrode calendering density leads to lower porosity and results in poorer electrolyte wettability.



Application

Wettability of Cathode and Anode Electrodes in Different Electrolyte Formulations



Conclusion

1. The wettability performance of both cathode and anode electrode sheets across different electrolyte formulations follows the order: Formula 3 < Formula 1 < Formula 2.
2. The calendering density of the anode electrode sheet is lower than that of the cathode, resulting in higher porosity and consequently better wettability.

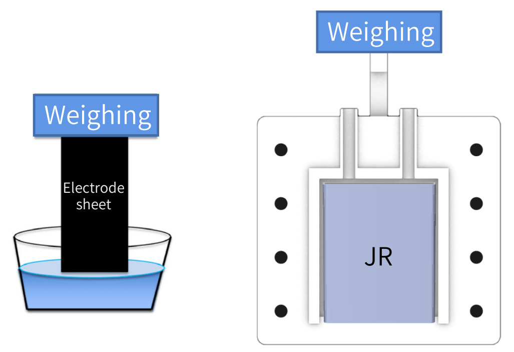
Model Table

Model	Parameters	
EWS1100 Electrolyte Wetting System	Pressure Control Range	0~500g
	Pressure Resolution/Accuracy	0.01g/±0.3%F.S
	Pixel Accuracy	10μm
	Suction Capacity	2μL
	Sample Size	29*29mm

ETS - Gravimetric Wetting Solution

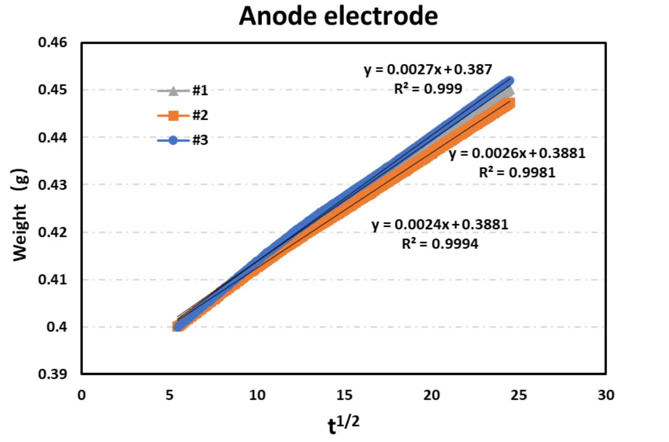
Features

- Recording weight changes during the electrolyte absorption process
- High-precision weighing system.
- In-situ & real-time characterization of electrolyte wetting rate of the electrodes.
- Applicable samples: Anode electrodes & Jelly Roll Cells.

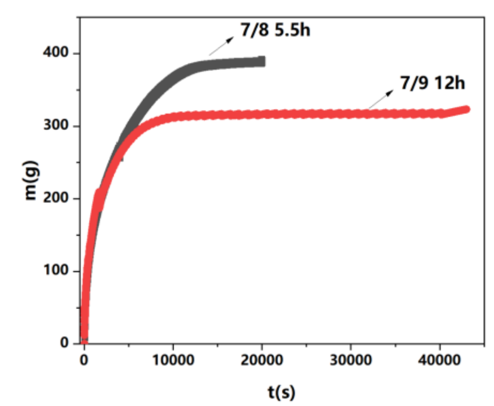


Application

3 sets of anode electrodes from same batch（65*70mm）



Two jelly roll cells with different winding layers



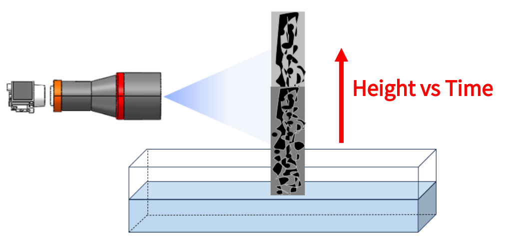
Model Table

Parameters	ETS 1100	ETS 2000
Weighing Range	0~220g	0~220g
Weighing Accuracy	±0.1mg	±0.1mg
Sample Size	65*70mm	65*70mm

CHT - Height Wetting Solution

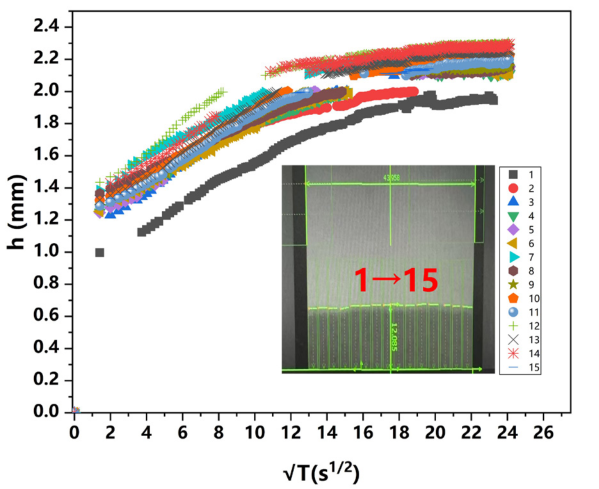
Features

- Recording Height changes during the electrolyte absorption process.
- High-precision vision inspection system.
- In-situ & real-time characterization of electrolyte wetting rate of the anode electrodes.
- Applicable samples: Anode electrodes, Cathode electrodes and Coated Seprators.

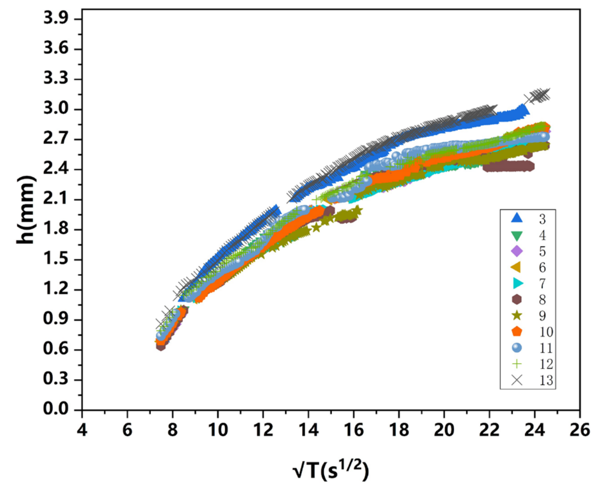


Application

Climbing height of separator (PCS facing outward)



Climbing height of Separator-Composite Anode test data

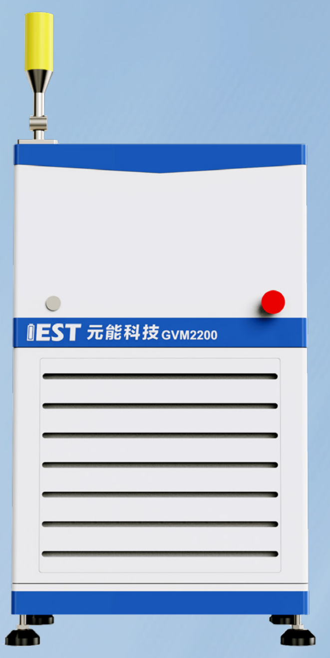


Model Table

Parameters	CHT-2000	CHT-2000 PRO
Dimensions (L×W×H)	610×780×620	1200×800×980
Sample	• Positive/Negative sheet • Coated Separator	• Positive Plate/Negative sheet/Scribed Negative Sheet • Coated Separator
Functions	• Multi-zone Climbing Analysis • Monochromatic Anti-corrosion and Light Transmittance Enhancement • Liquid Level Stabilization System (Optional)	• Multi-zone Liquid Climbing Height • Multicolor Anti-corrosion and Light Transmittance Enhancement • Automatic Sampling: (5-sample Chamber as Standard, 10-sample Chamber Optional) • Liquid Level Stabilization System • RFID Sample Information Identification

In-Situ Gassing Volume Analyzer

Scan QR code
for details

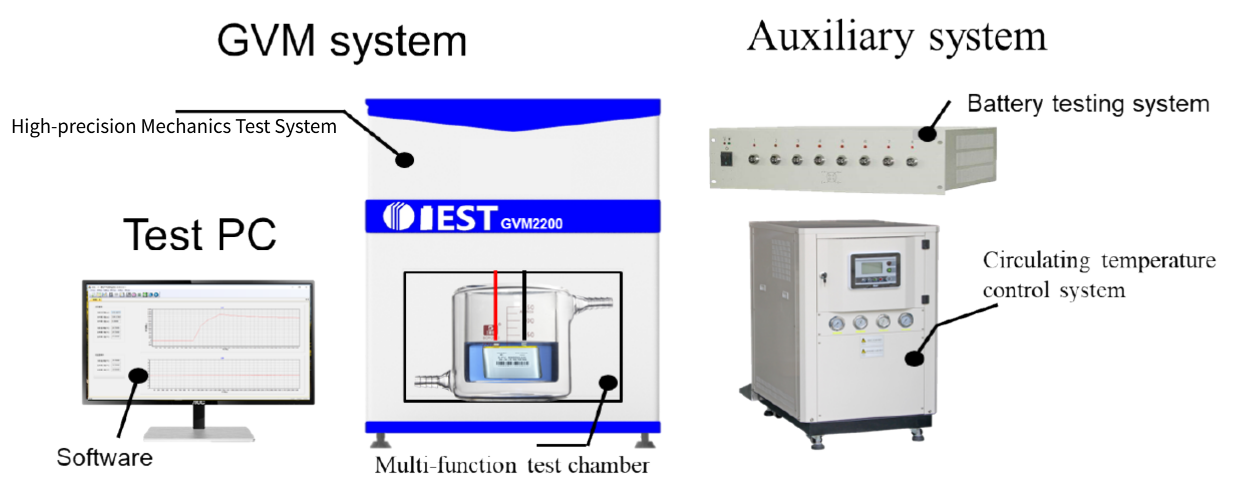


Model Table

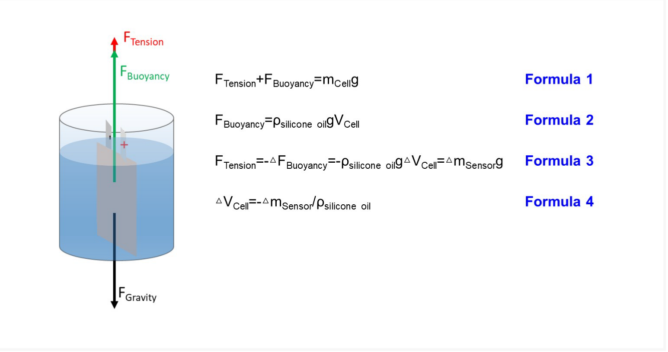
Model	GVM2100	GVM2200	GVM2150
Channel	Single (1 Cell)	Dual (2 Cells)	Single (1 Cell)
Maximum Cell Weight (Including Fixture)	1000g	1000g	5000g
Test Temperature	RT~85℃	RT~85℃	RT~85℃
Volume Change Resolution	1μl	1μl	10μl
Volume Change Measurement Precision	±10μl	±10μl	±30μl
System Stability	≤20uL(RT, ≤60min)	≤20uL(RT, ≤30min)	≤50uL(RT, 30min~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, and our specifications are subject to change without prior notice.

Creative solution - in-situ gassing monitor system



Instrument Principles



By integrating Newton's law (Formula 1) and Archimedes' buoyancy principle (Formula 2), specialized sensors are used to measure the real-time mass changes of the cell during the charge & discharge process, and then the cell's volume changes can be further calculated(Formula 3 and 4).

Product Features

Multi-Level Gassing Testing: Material Gassing → Single-Layer Stacked Cell Gassing → Small Pouch Cell Gassing → Cylindrical & Prismatic Cell Gassing

Multi-Channel Gassing Testing: Single Channel → Dual Channel → 8-Channels Testing

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

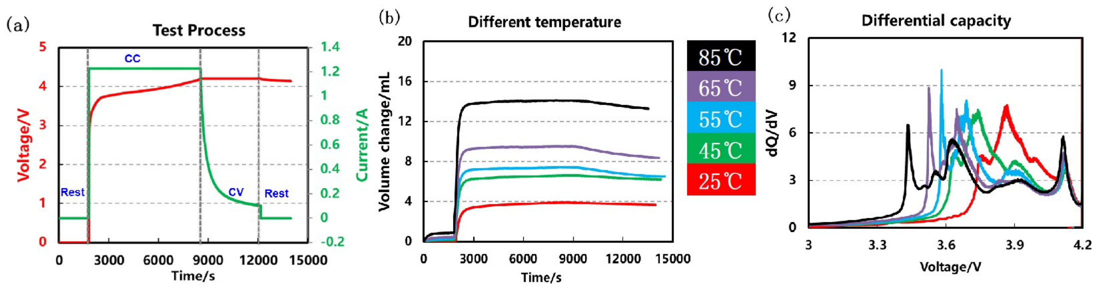
Comprehensive Gassing Analysis: Gassing Volume → Gassing Pressure → Gassing Composition Analysis

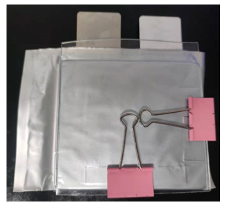
Applications

- **Overcharge Gassing**
- **Cycle Gassing**
- **Storage Gassing**
- **Formation Gassing**

Application Case - Formation Gassing

Formation at different temperatures



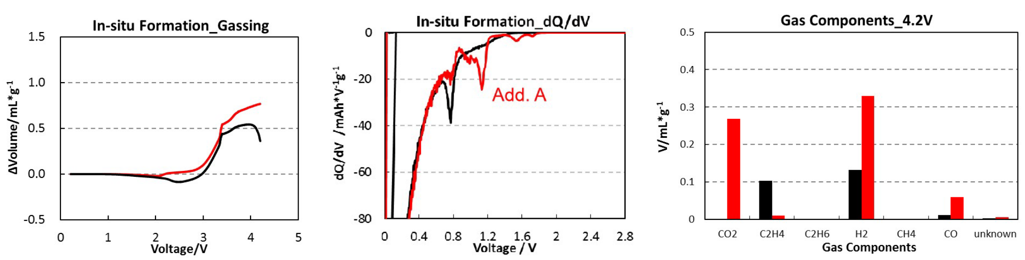


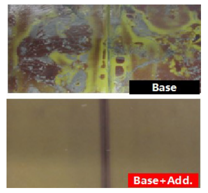
Test Conditions: NCM/Gr Pouch Cell   Rate: 0.5C   Charging: CC 4.2V   Capacity: 2400mAh

Conclusion: The gas production increases gradually with the increases of formation temperature, and when formation temperature is around 55°C, the first phase transition reaction peak will be more acute.

In addition, From the differential capacity (dQ/dV) curve, higher formation temperatures correlate with steeper slopes at the onset of gas generation.

Formation with different electrolyte additives



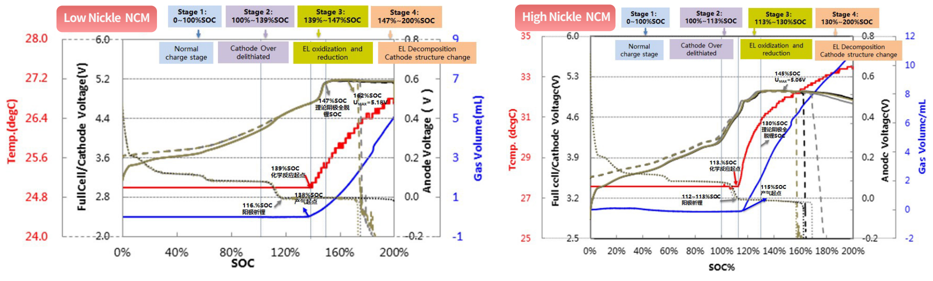


Test Conditions: Temp: 25°C   Rate: 0.02C

Conclusion: The gas production & gas production rate of the cells with additive A(red) are greater than those without the additive, which means this additive enables a more complete **SEI formation** in the cells.

Application Case - Overcharge Gassing

NCM cells with different Ni contents



Note: EL is the abbreviation for electrolytes.

Test Conditions

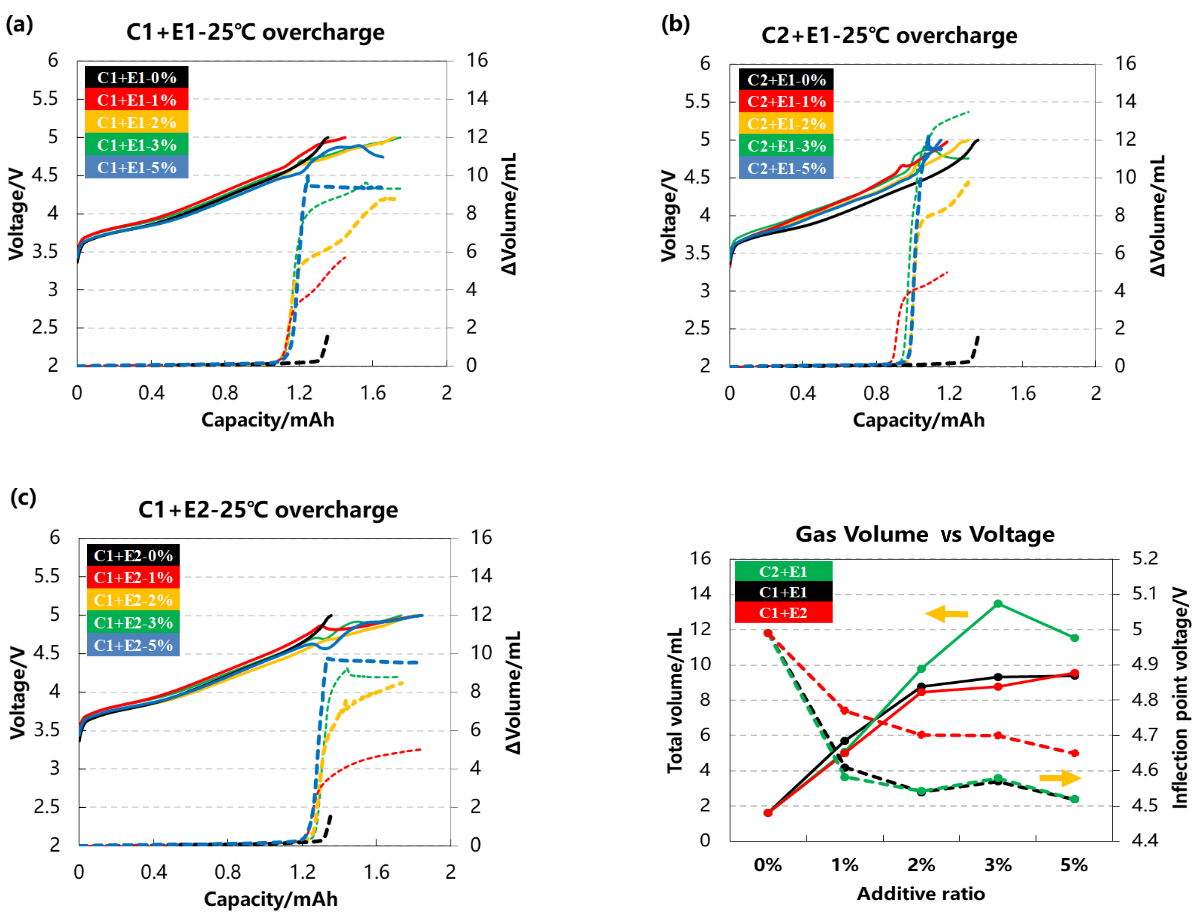
Temperature: 25°C

Rate: 0.5C

Conclusion

1. During the Formation Process, the slope of the volume change curve abruptly increases when overcharged to a critical potential. This triggers a sharp rise in cell surface temperature, followed by immediate gas generation.
2. As the nickel content increases, the state of charge (SOC) at the onset of gas generation shifts from 138% to 115%.

Cells with different cathodes and contents of electrolyte additives

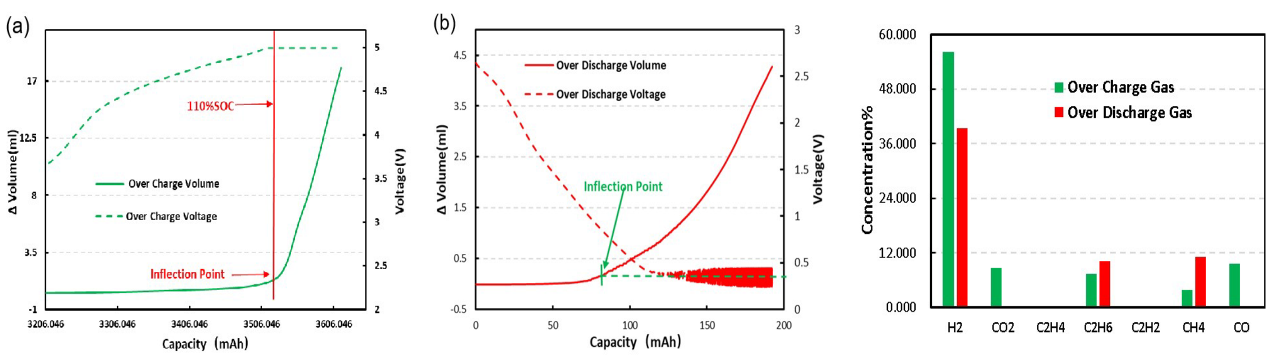


Note: C: Cathode electrodes   E: Electrolyte additives

Additives contents	Gassing volume 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

Conclusion: Both cathode electrodes and the contents of electrolyte additives affect gas production, while the type of additives mainly affects the potential of gas production.

Overcharge and overdischarge of LFP batteries



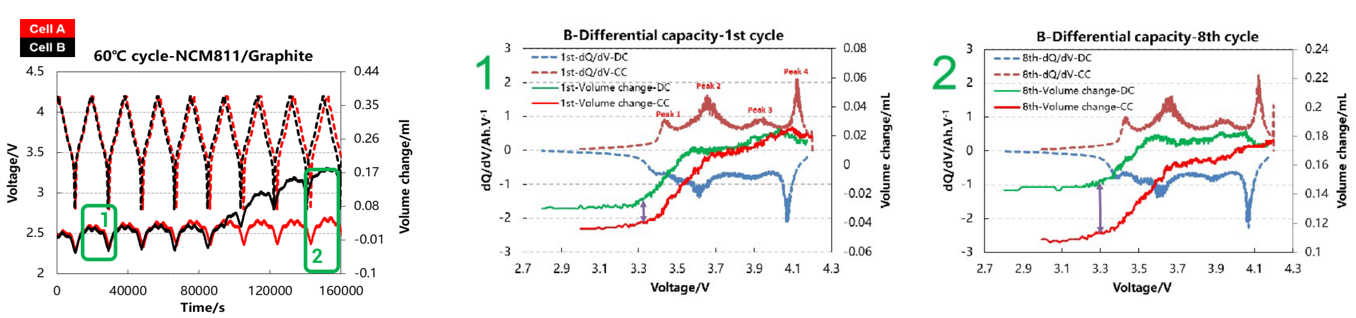
Test Conditions: ⊘ LFP/Graphite Cells ⊘ 0.5C CCCV to 5V ⊘ 0.5C DC to 0V

Conclusion

1. As the cell is overcharged or overdischarged, the starting point of gas production can be detected in real time;
2. Gas chromatography(GC) 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.

Application Case - Cycling Gassing

Cycle performance of different NCM cells

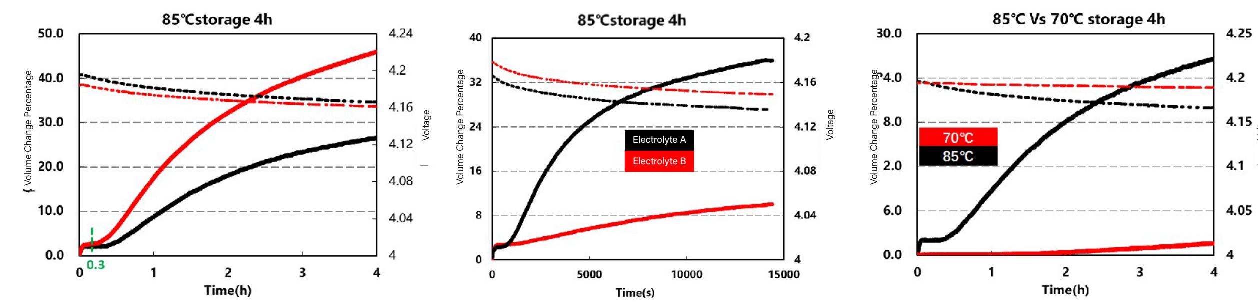


Test Conditions: ⊘ NCM/Gr Pouch Cell ⊘ Temperature: 60°C ⊘ Rate: 0.5C ⊘ Voltage: 3-4.2V

Conclusion: The volume change of cell B is greater than that of cell A, and the gap of volume change deepens with the increase of cycles, which indicates the irreversible volume swelling increases as well.

Application Case - Storage Gassing

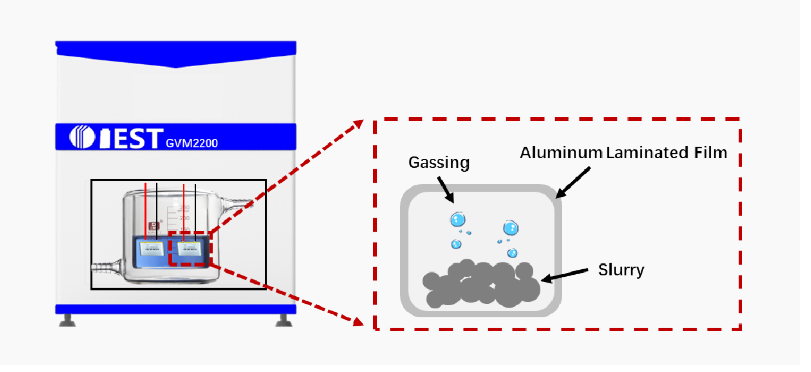
Storage Gassing under 3 different conditions

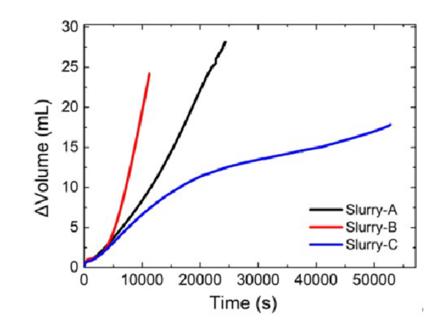


Test Conditions: ⊘ 4.2V fully charged ⊘ storage at 85°C for 4h

Conclusion: Different cathode materials, electrolytes, and storage temperatures all affect the volume change of the cells.

Gassing from silicon-based slurries

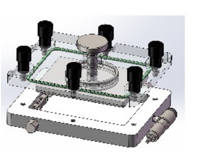




Conclusion

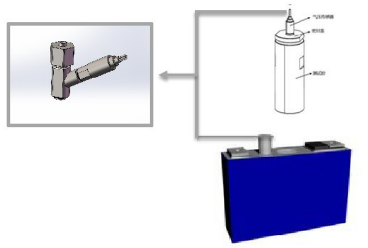
1. Pre-magnesium or pre-lithiation treatment of silicon monoxide results in gas generation in the slurry.
2. Lithium compensation additives in the cathode tend to decompose and generate gas during the actual slurry and lithium compensation process.

Comprehensive gassing solutions

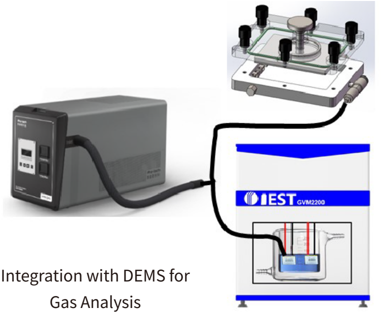


Stacked Cell Molds

Multi-Channel Gassing Testing

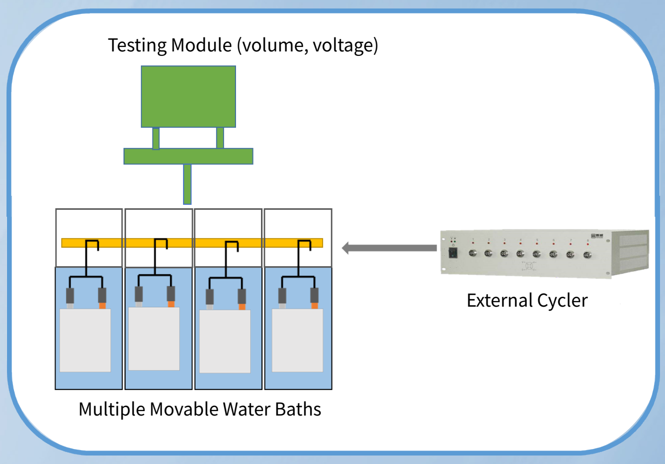


High-Precision Pressure Sensors



Integration with DEMS for Gas Analysis

In-situ Multi-Channel Storage Gassing Test System



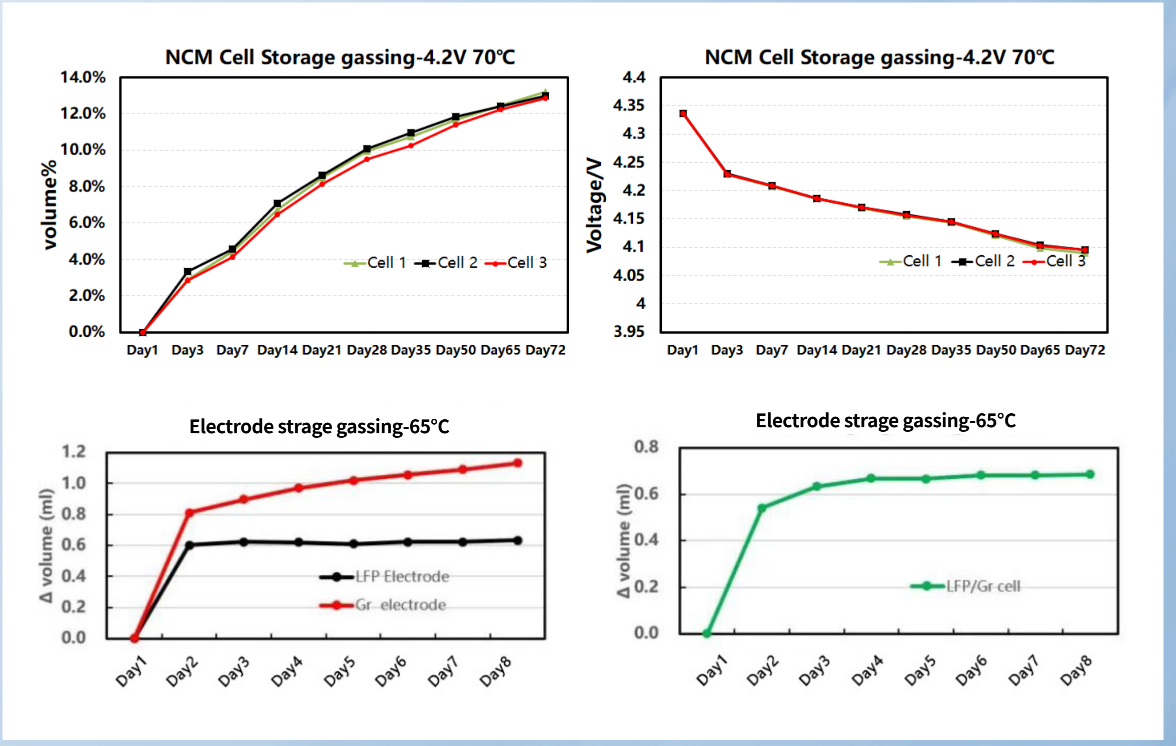
Features

In-situ Storage Gassing testing for **pouch cells**

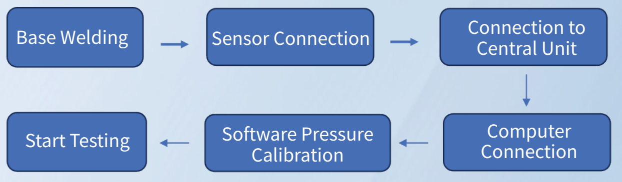
Multi-channel Testing (up to **64 channels**)

Automatical Data Recording(volume, voltage and internal resistance)

Applicable to External Cyclers



Prismatic & Cylindrical Cell Internal Pressure Testing System



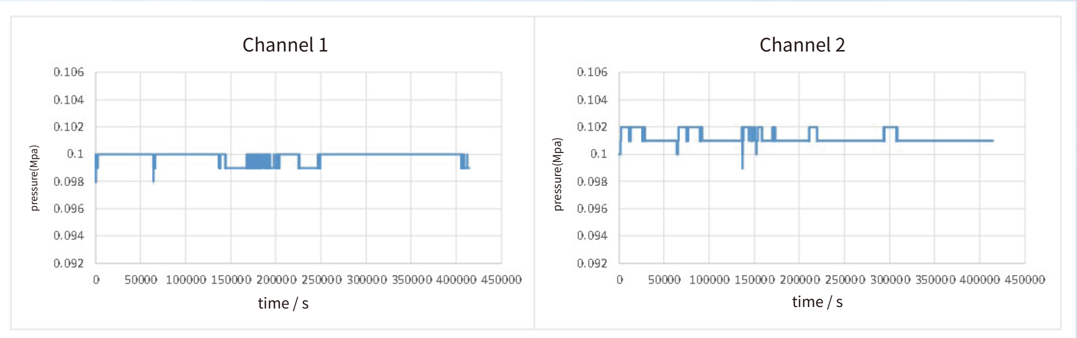
Applicable Samples: Cells with the **diameter of liquid injection port ＞7mm**

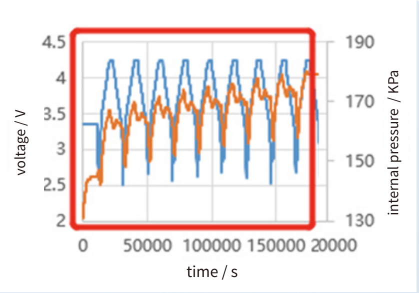
Measure Range: 0.5MPa, 1MPa, 1.5MPa, 2MPa

Test Duration: up to 6 months

Sensor Accuracy: 0.3% F.S.

Number of Channels: 8





Test conditions: 60°C atmospheric pressure test

Test results: 115 hours, 0.003MPa fluctuation

Conclusion: 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 Solutions

Scan QR code for details

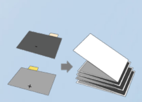
- Model Coin-cell Swelling Analyzer (MCS Series)
- In-Situ Rapid Swelling Screening For Silicon-Based Anode(RSS Series)
- In-situ Swelling Analyzer for Consumer Battery/Cells (CBS Series)
- In-situ Swelling Analyzer for Power and Energy Storage Cells (SWE Series)
- Battery Pressure Distribution Film (BPD Series)

Comprehensive Solution for Cell Swelling

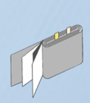
Model Coin Cell | Silicon-Based Anode | Consumer Battery | Consumer Battery & Power Battery & Energy Storage Battery | Battery Pressure Distribution Measurement System

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

Model coin cell



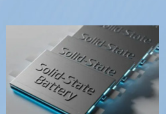
Stacked Cell



Pouch Cell

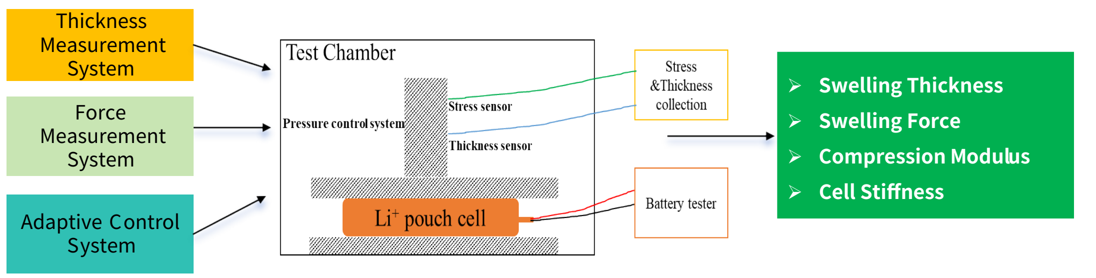
Square Cell

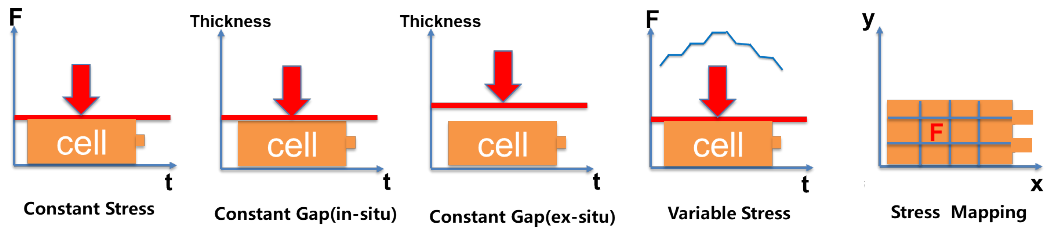
Short-blade Cell (<700*400*100 mm)



Solid-state Batteries

Instrument Principle





Test Range & Accuracy

- Force: 1kg~10T(Accuracy: 0.3% F.S.)
- Displacement: 0.1mm~100mm Accuracy: ±1μm
- Number of channels: 1-4 channels
- Temperature: -20°C~80°C

Specifications

Model		MCS1410	RSS1410	CBS1410
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	1/2/3/4	1/2/3/4	1/2/3/4
Pressure Control	Pressure Adjustment Range	5kg	0-100kg	0-500kg
Pressure Measurement	Accuracy	/	±0.3% F.S.	±0.3% F.S.
Expansion Thickness Measurement	Measurement Range	0~5mm	0~5mm	0~6mm
	Resolution	0.01μm	0.01μm	0.01μm
	System thickness measurement accuracy	±1μm	±1μm	±1μm
Temperature Chamber		×	√(optional)	√ (optional)
Dimension		600*315*380mm	1500*700*1650mm	1600*700*1650mm
Weight		53kg	430kg	430kg

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Equipment Specifications

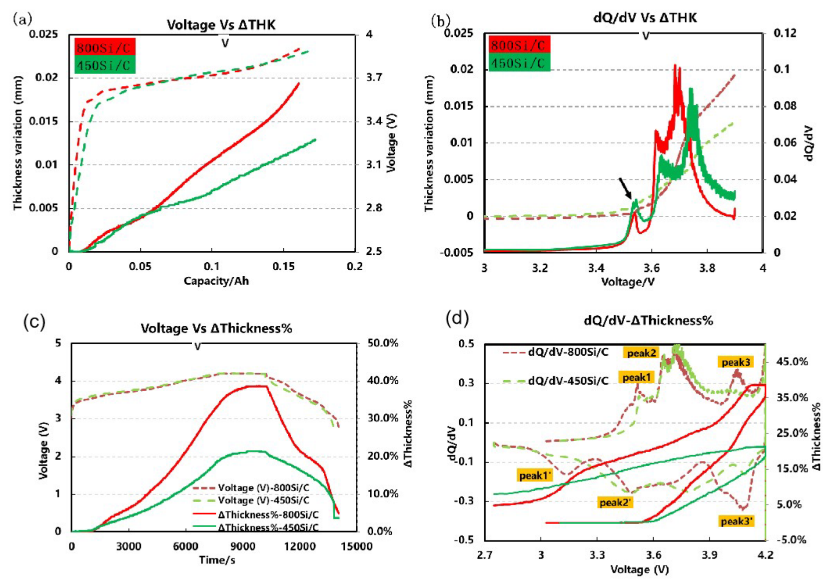
Model		SWE2100	SWE2110	SWE2500	SWE2510
Test Mode	Constant Gap	√	√	√	√
	Constant Pressure	√	√	√	√
	Steady-state Compression	√	√	√	√
Applicable Cell	Cell Type	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell	Pouch Cell Prismatic Cell
	Maximum Cell Size	220*180mm	220*180mm	400*300mm	400*300mm
	Number of Channel	1	1	1	1
Pressure Control	Pressure Method	Servo Motor	Servo Motor	Servo Motor	Servo Motor
	Pressure Adjustment Range	0-1000kg	0-1000kg	0-5000kg	0-5000kg
Swelling Thickness Measurement	Resolution	0.1μm	0.1μm	0.1μm	0.1μm
	Accuracy	±1μm	±1μm	±1μm	±1μm
Temperature Control	Temperature Control Range	-20~80°C	×	-20~80°C	×
	Accuracy	±2°C	×	±2°C	×
Dimension		700*1220*1850mm	410*455*980mm	1100*1600*2000mm	820*750*1650mm
Weight		490kg	150kg	1100kg	850kg

Product Features

1. **Multi-Level In-Situ Swelling Test**: Electrodes, Pouch Cell, Prismatic cell, Short-blade Cell
2. **Multi-Channel Swelling Test**: Single-channel → Dual-channel → Four-channel
3. **Temperature Control**: -20°C~80°C
4. **Wide Force Ranges**: 5kg → 100kg → 300kg → 1000kg → 5000kg → 10000kg

Application Case - Materials Evaluations

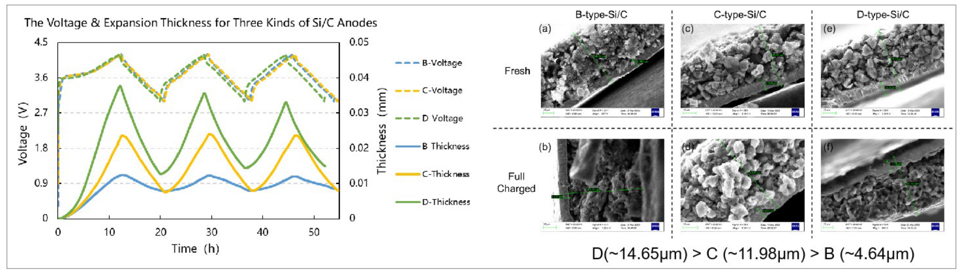
Formation & charge-discharge swelling test of different Si/C contents cells



Test Conditions: Pouch Cell(stacking) 200 mAh (1 cycle) Cathode: NCM811
Anode: 450Si/C (450 mAh/g) 800Si/C (800 mAh/g)

Conclusion: The higher the **silicon content** in the anode, the greater the swelling is(Max thickness change is around 40%), and the silicon-lithium alloy formed will affect graphite' s **phase transition potential** of lithium intercalation.

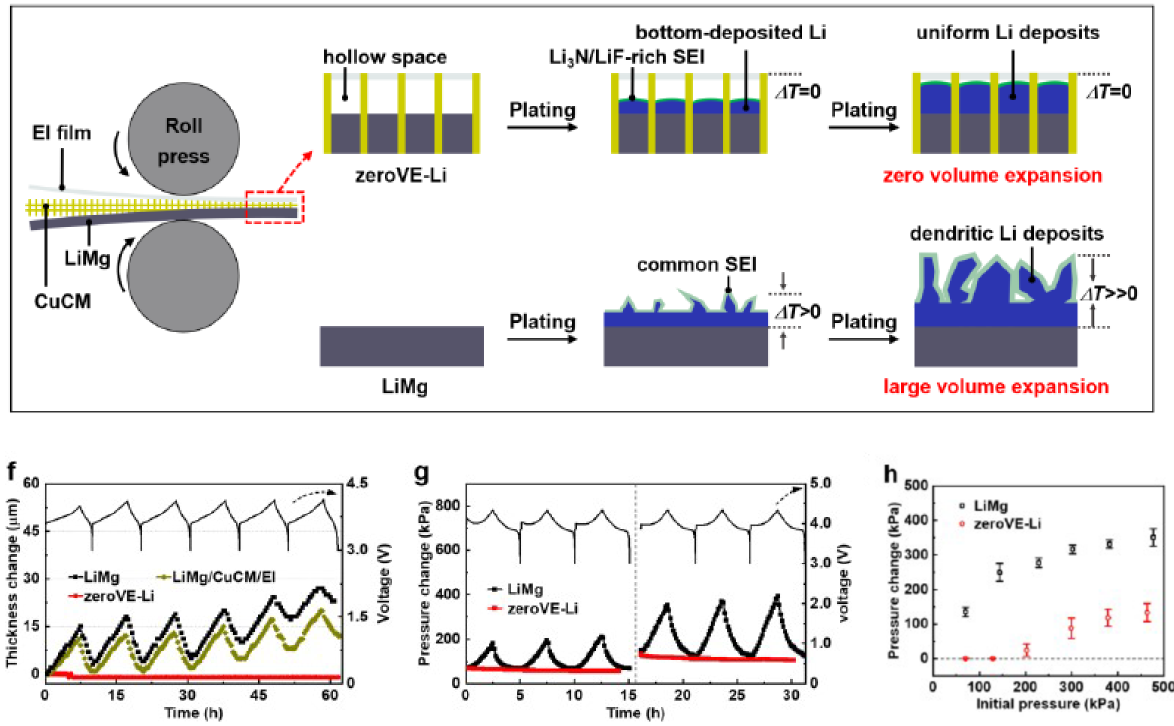
Anode: NCM-Si/C cells with different modifications



Test Conditions: NCM-Si/C Coin Cells Si/C#D(~14.65μm) Si/C#C (~11.98μm) Si/C#B(~4.64μm)

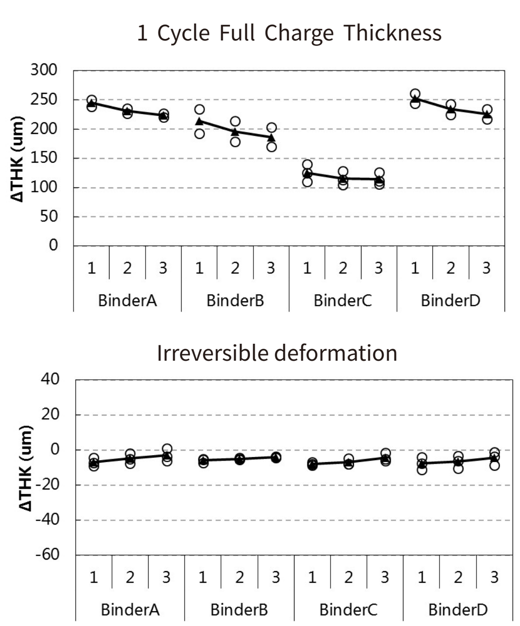
Conclusion: Si/C#B shows the minimum swelling volume, and the swelling performance of the 3 anode materials share the same trend observed with the SEMs.

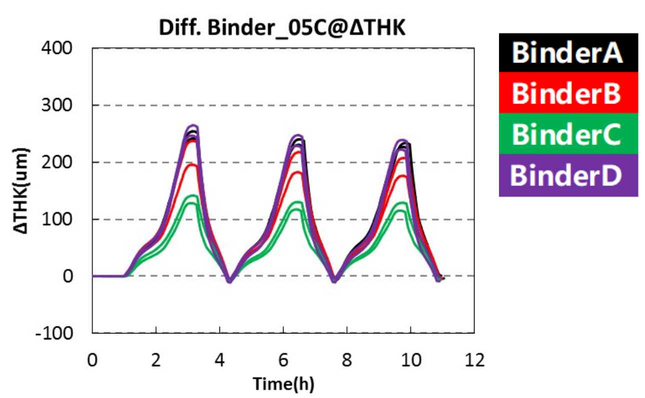
Cycle swelling of cells with different Li metal



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

Cycle swelling of cells with different binders

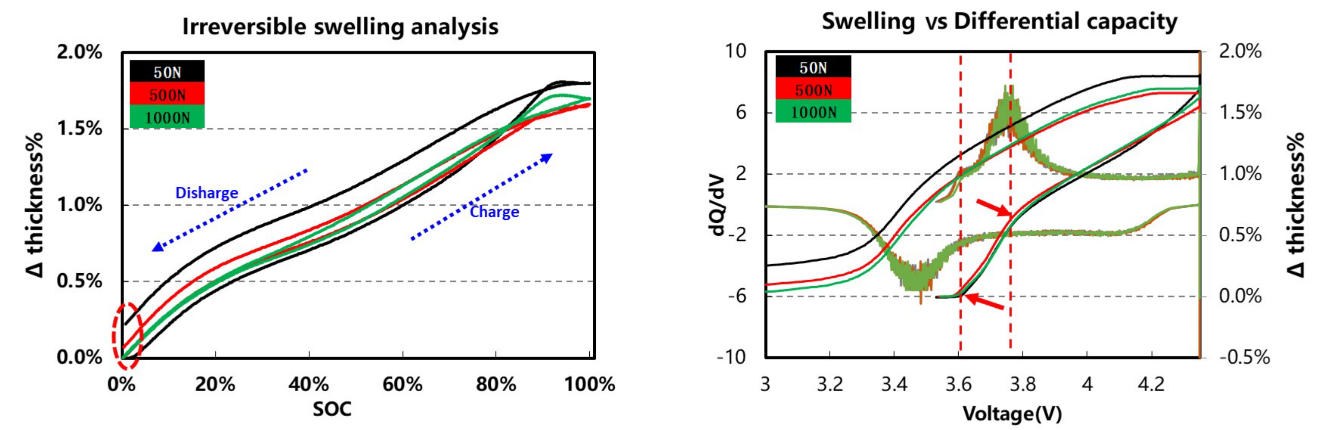




Conclusion: The irreversible swelling of the 4 tested cells is similar, and the main difference lies in the **swelling thickness after one cycle of full charge**, that cells with **binder C** outperformed the others.

Application Case - Process Conditions

Swelling of prismatic cells under different pre-stress

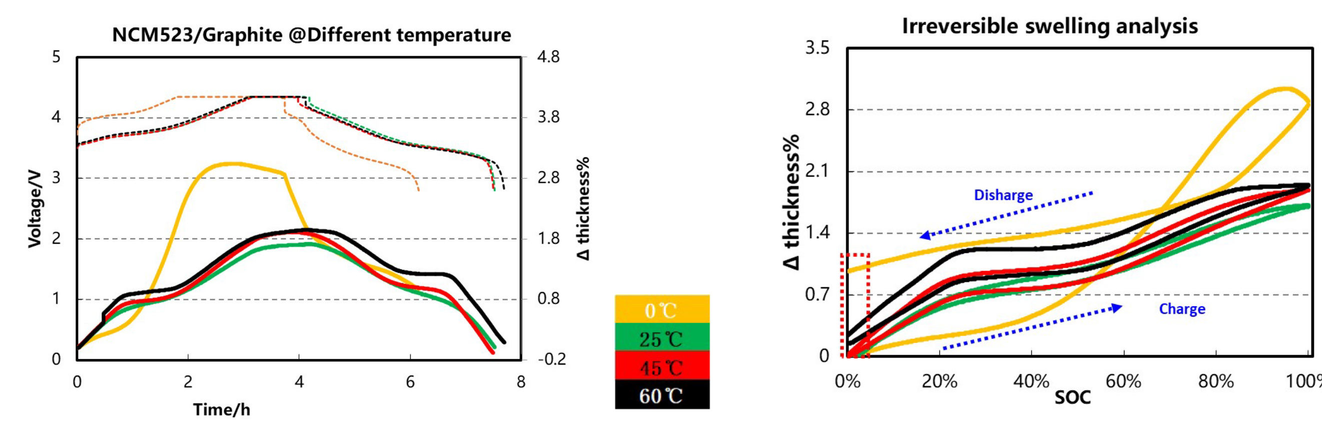


Test Conditions: ⊘ NCM523/Gr Prismatic Cells(2400 mAh) ⊘ 34cm*46cm*106cm(T*W*L) ⊘ Pre-stress: 50N/500N/1000N

Conclusion

1. The proportion of irreversible swelling of the cells can be reduced by increasing the pre-stress.
2. During the charge process, the 2 inflection points of the swelling curve correspond to the 2 peaks of the differential capacity curve, indicating that the swelling of the cell is related to the phase transition of lithium intercalation & deintercalation.

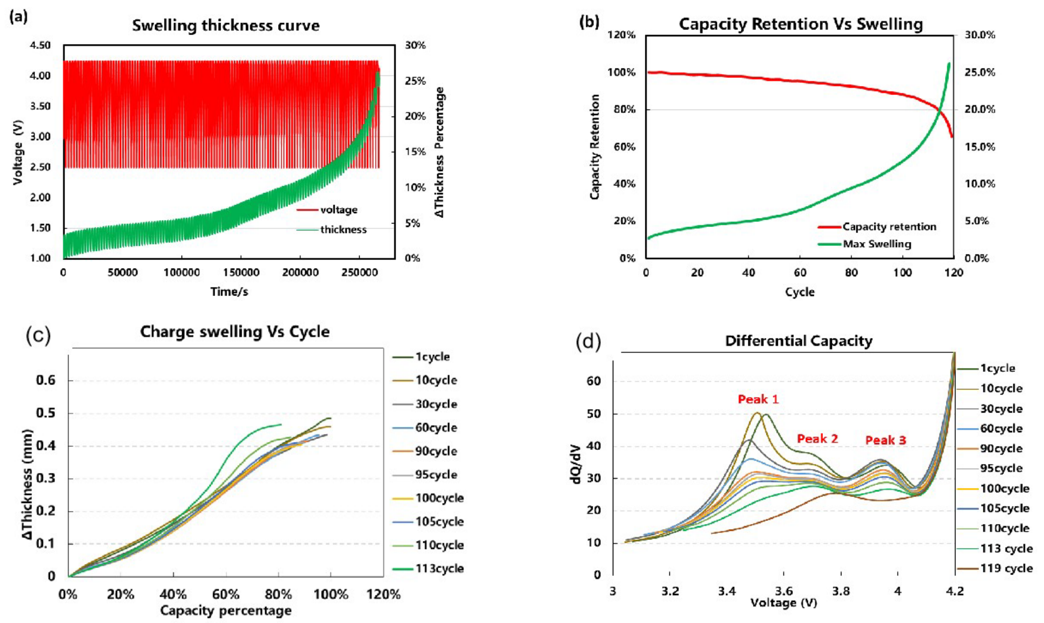
Swelling of prismatic cells under different temperature



Test Conditions: ⊘ NCM523/Gr Prismatic Cells(2400 mAh) ⊘ 34cm*46cm*106cm(T*W*L)
⊘ Temperature: 0°C/25°C/45°C/60°C

Conclusion: The **irreversible swelling of the cells increases** in both cases when the temperature increases from 25°C to 60°C, as well as decreases from 25°C to 0°C. However, the causes of such swelling under high-temperature and low-temperature conditions may differ.

Swelling of prismatic cells under different cycles



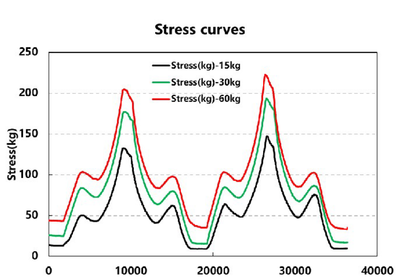
Test Conditions: ⊘ NCM811/Gr Prismatic Cell (50 Ah) ⊘ Voltage: 3V~4.2V ⊘ Rate: 1C

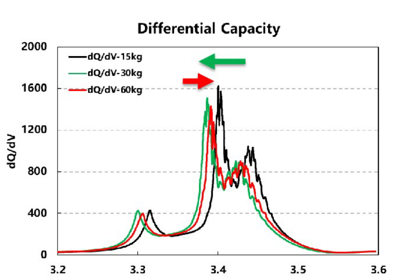
Conclusion

1. The **swelling curve** of the cell corresponds to its **capacity attenuation curve**. Generally, when there is a sudden drop in capacity (the intersection point of the 2 curves), it is either due to gas generation or side reactions.
2. Lithium plating may occur after 115th cycle.

Swelling of prismatic cells under different pre-stress

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





Test Conditions

⊘ LFP/Gr Prismatic Cells(100 Ah)

⊘ Pre-stress: 15kg/30kg/60kg

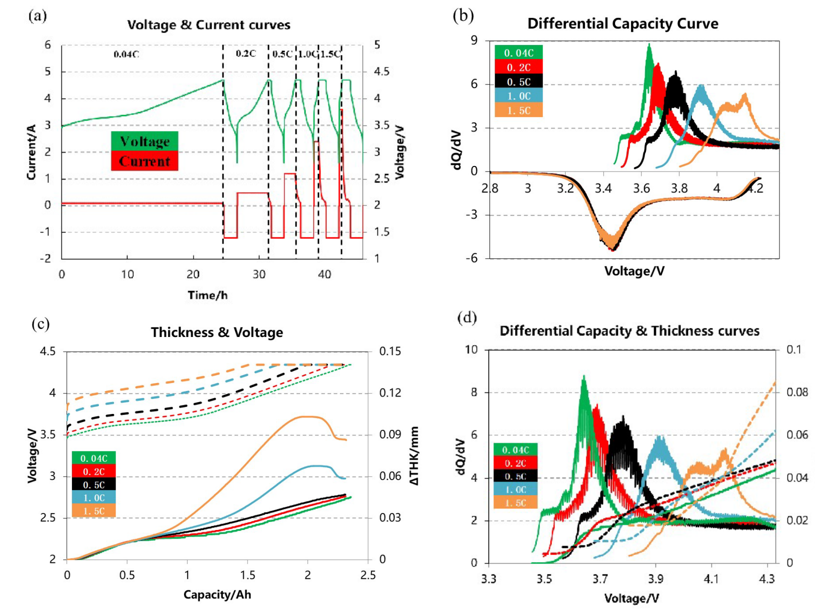
Conclusion

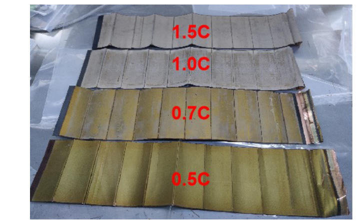
1. The **initial gap** of the cells gradually **decreases** with the increase of pre-stress, and the **variation in swelling force** becomes more significant during the charge and discharge process.

2. The **charge polarization** of the cells first decreases and then increases with the increase of pre-stress, indicating that a pre-stress of around **30kg** is beneficial for improving **the rate performance of prismatic cells**.

Non-destructive lithium plating analysis

Lithium plating under different rate



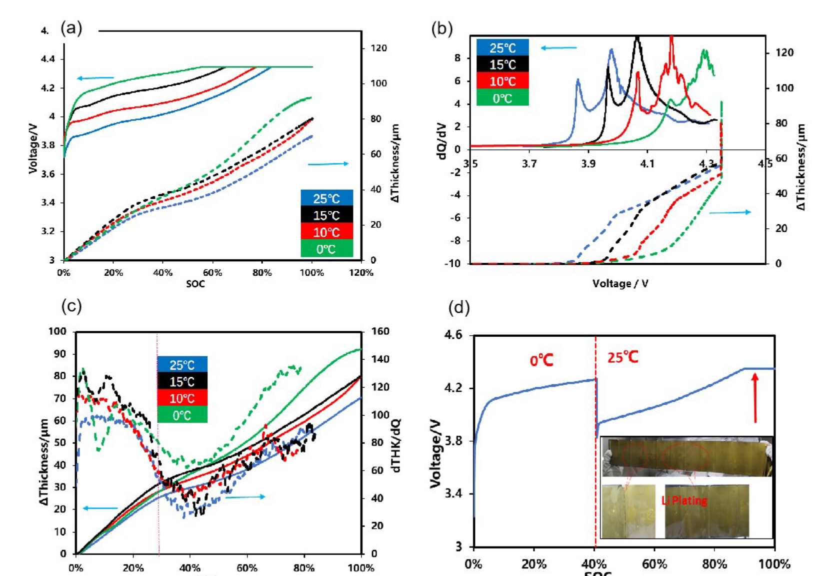


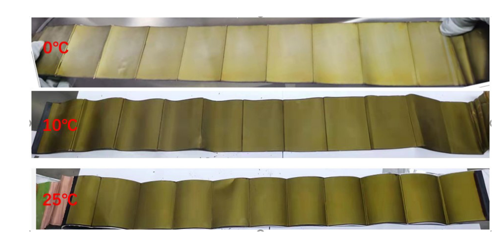
Test method: Charge the cells at different rates and discharge them at the same rate to analyze the differences in their voltage curves and swelling thickness curves.

Conclusion

1. The slope of the cell' s thickness curve increase with the increase of rate.
2. Lithium plating gets more and more serious with increase of rate.

Lithium plating under different temperature



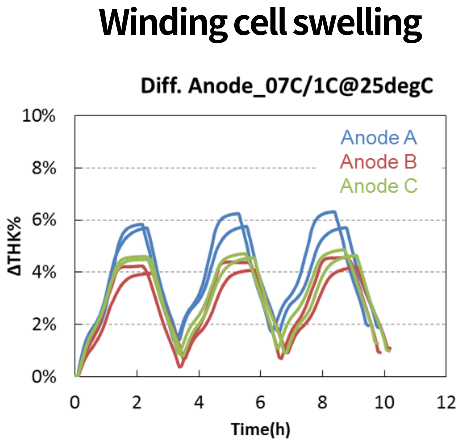


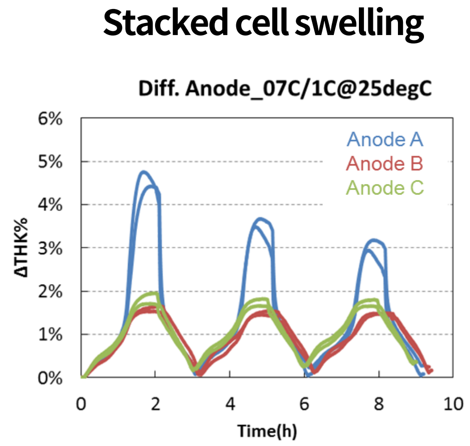
Test method: In situ detect the thickness curves of batteries with different temperatures.

Conclusion: 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.

Application Case - Cell structure

Multi-layer jelly rolls vs. Single-layer stacked cells

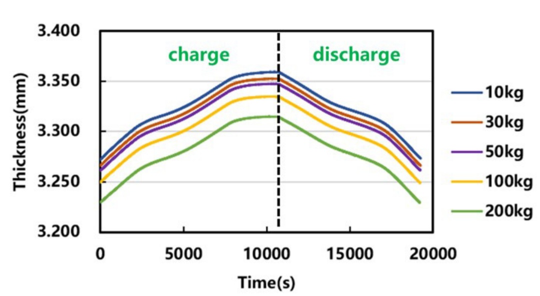


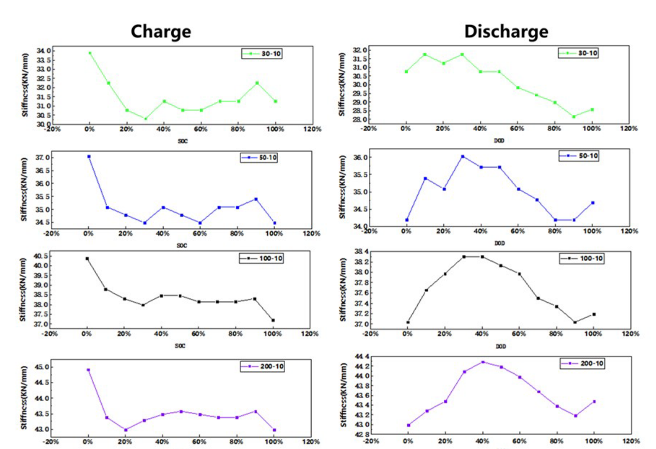


Conclusion: The swelling ratio of jelly rolls is greater than that of stacked cells, cause the stress in stacked cells can partially release in all directions, resulting in a smaller overall swelling thickness.

Swelling stiffness vs Compression stiffness under constant pressure

Test Conditions: ✓Cell：LCO/GR 2400mAh ✓Constant pressure：10/30/50/100/200kg





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

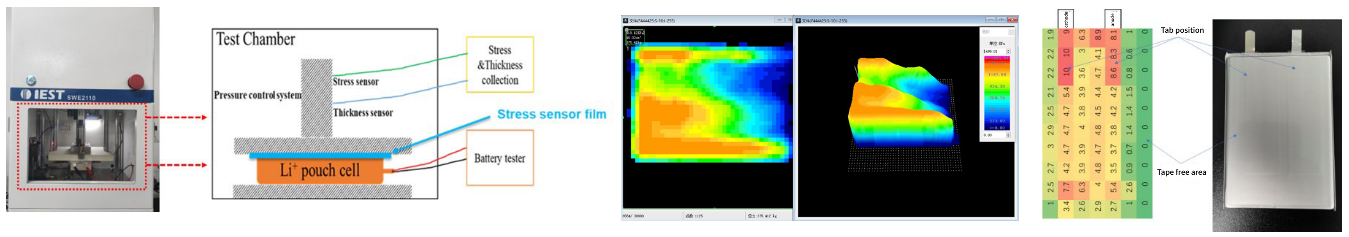
SOC \ stress stiffness (KN/mm)	30-10	50-10	100-10	200-10
0%	33.9	37.0	40.4	44.9
30%	30.3	34.5	38.0	43.3
50%	30.8	34.8	38.5	43.6
80%	31.3	35.1	38.1	43.4
100%	31.2	34.5	37.2	43.0

Conclusion

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

Battery Pressure Distribution Film

Application

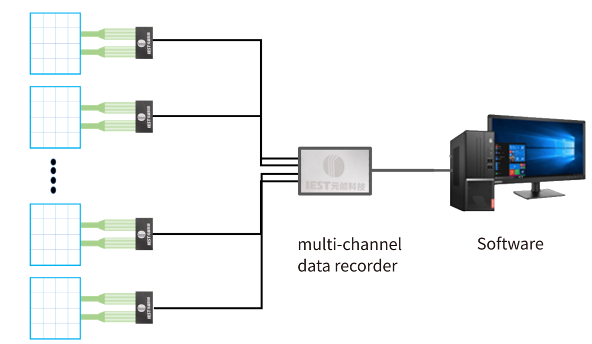


Features

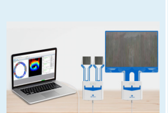
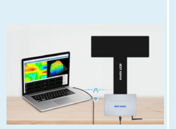
Real-time monitoring of mechanical stress during charge/discharge cycles.

One click test data export.

Visualization of cell pressure distribution (Uniformity).



Model Table

Image	Model	Points Supported	Range (MPa)	Precision	Thickness	Temp. Range &Accuracy	Temp. Sensing Points	Collection Equipment	Software
	BPD1100-M	Up to 2288 points (max density: 248/cm²)	0.2-2MPa, 0.3-3MPa, 0.5-5MPa, 1-10MPa, 2-20MPa	3%-10%	⩽0.35mm	/	/	1. Data transmission: USB2.0 2. Interface: Quick self-locking aviation plug 3. Power: 2.5W (5V, 0.5A) 4. Scanning frequency: Max 100Hz 5. Resolution: 256 (8bit) 6. Weight: < 1kg	1. Pressure lattice, 2D/3D images. 2. Real-time data analysis, recording. 3. Playback functions (record, load, fast-forward, etc.). 4. Real-time display of unit pressure, curves. 5. Data import/export. 6. Range selection for scenarios.
	BPD1100-L	Up to 9152 points (max density: 248/cm²)							
	BPD1100-T	Up to 9152 points (max density: 248/cm²)	1-10MPa		⩽0.5mm	-20~120°C (±1°C)	9/15/64	1. Data transmission: USB2.0 2. Interface: Quick self-locking aviation plug 3. Power: 2.5~5W 4. Power adaptor: 5V, 2A 5. Scanning frequency: Max 100Hz 6. Resolution: 256 (8bit) 7. Weight: < 1kg	

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

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

Electrochemical Performance Analyzer

Scan QR code for details

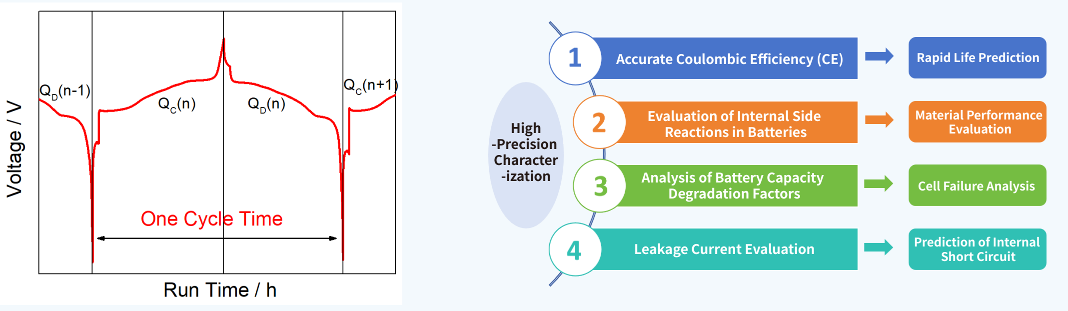
Model Table

No.	Product Name	Model	Current Range	Description	Key Features
1	ECT Series	ECT6008 - 5V 100mA Voltage: ±5V	4-range auto switch 10nA~0.1mA~1mA~10mA~100mA	/	• Current & Voltage Control Accuracy: 0.01% / 0.02% / 0.05%
		ECT6008 - 5V 6A/12A Voltage: 0~5V	4-range auto switch 0.6μA~6mA~60mA~0.6A~6A 1.2μA~12mA~120mA~1.2A~12A		
2	ERT-6 Series	ERT6008 - 5V 100mA Voltage: ±5V	4-range auto switch 10nA~0.1mA~1mA~10mA~100mA	• Channels: 8 • Max. Sampling Rate: 100 SPS • Response Time: 5 ms • Temp. Range: 10~80°C (Optional) • Functions: Voltage/Current/Time Curve, Capacity/Cycle Curve, dV/dQ Curve, DCIR, GITT, PITT, CA/CP	• C & V Control Accuracy: 0.01% • Function: CV, LSV
		ERT6008 - 5V 6A/12A Voltage: 0~5V	4-range auto switch 0.6μA~6mA~60mA~0.6A~6A 1.2μA~12mA~120mA~1.2A~12A		
3	ERT-7 Series	ERT7008 - 5V 100mA Voltage: ±5V	4-range auto switch 10nA~0.1mA~1mA~10mA~100mA		• C & V Control Accuracy: 0.01% • Function: CV, LSV, EIS • EIS Frequency Range:100k~0.01 Hz • EIS Samples:Electrode, coin cell, small pouch cell (≤3Ah) SV
		ERT7008 - 5V 6A/12A Voltage: 0~5V	4-range auto switch 0.6μA~6mA~60mA~0.6A~6A 1.2μA~12mA~120mA~1.2A~12A		

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

High-Precision Current/Voltage (I/V) Testing

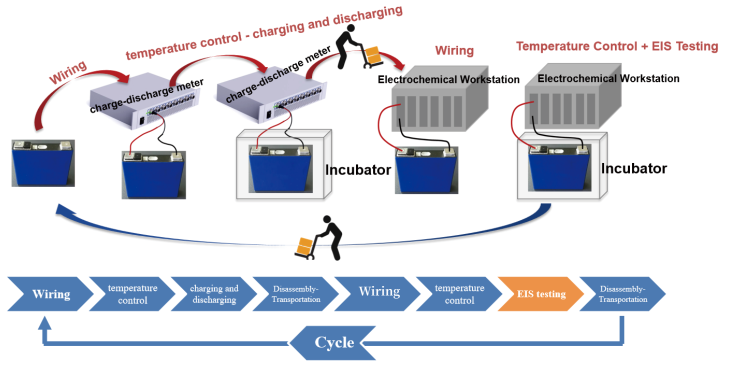
Accuracy Comparison — IEST: 0.01% vs Others: 0.05%



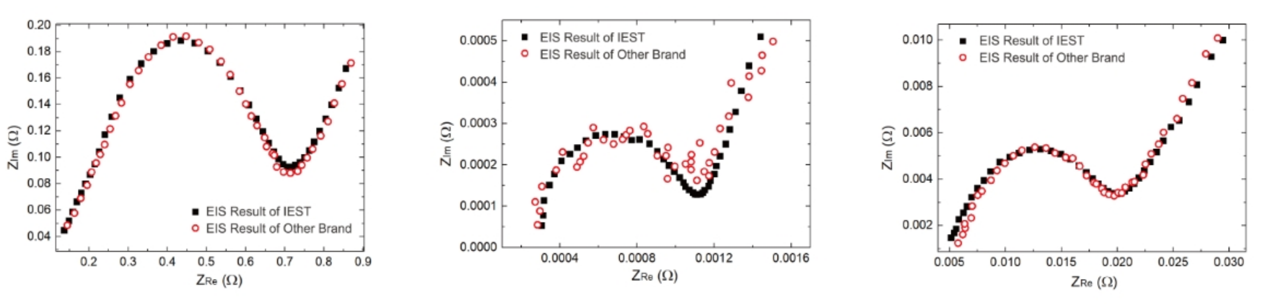
With 0.01% testing accuracy, the system precisely measures new material specific capacities and identifies subtle side reactions during early cycling stages.This allows for a comprehensive performance evaluation and lifetime prediction of the battery in a short period.

CV & EIS + Battery Cycler

Traditional Method

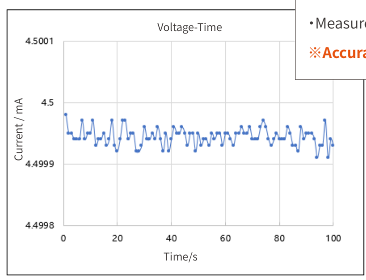


IEST Method

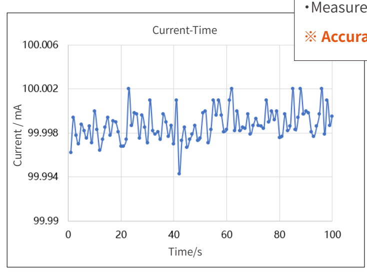


Minimize wiring, handling, and temperature adjustments, streamline operations

ECT & ERT Series: Precision Testing 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

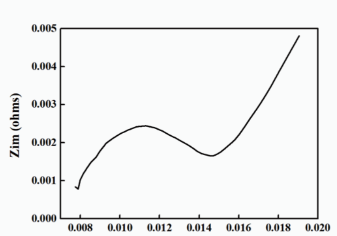
Product	Test Items	Function
ECT/ERT All Series	Constant current, constant voltage, constant power, constant resistance, rate mode, etc.	Conventional charging and discharging functions
ECT/ERT All Series	Capacity-cycle curve, dQ/dV curve, dV/dQ curve, PITT、GITT、DCIR, etc.	Study the relationship between 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-7 Series	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.

Offer common functions of an electrochemical workstation

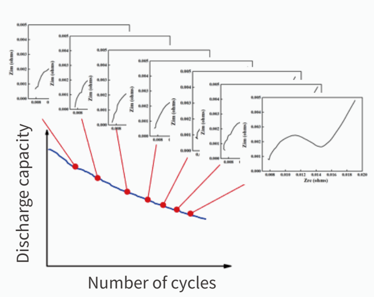
The ERT series includes common electrochemical workstation functions such as CV, LSV, EIS, CA, and CP.

Case 1: EIS Test

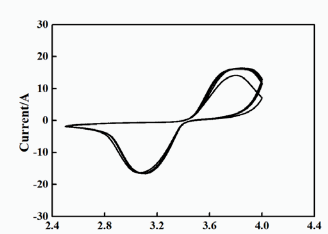


2.2Ah Pouch cell Impedance Test
[Frequency: 100KHz～0.1Hz]

Case 2: Cyclic EIS Test

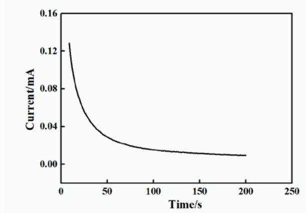


Case 3: CV (Cyclic Voltammetry) Test

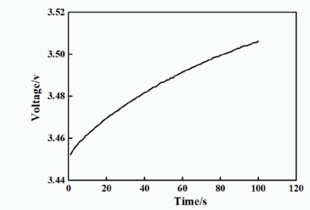


CV test of 120mAh Pouch cell
[Scan speed: 1mV/s]

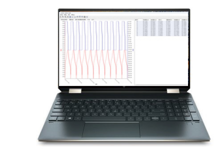
Case4：CA·CP Test



120mAh Pouch cell CA Test



120mAh Pouch cell CP Test

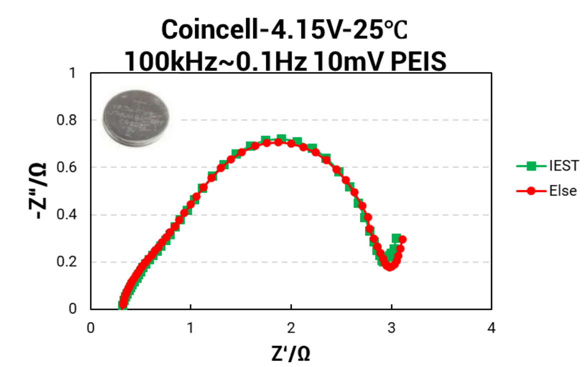


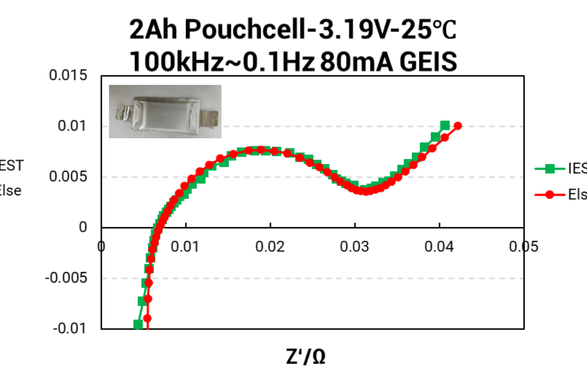
- EIS
- CV
- LSV
- CA
- CP
- GITT

One-step solution for electrochemical experiments

Comparison of EIS results with other other brands

High-frequency EIS impedance: 0.01Hz~100kHz, meeting the high-frequency impedance test requirements of 10mΩ~kΩ level batteries





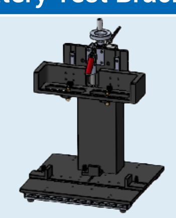
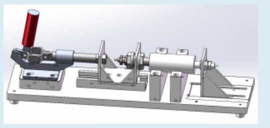
Compared with the EIS test results of well-known foreign electrochemical workstations, the error is within 5%.

Battery Impedance Tester

Scan QR code
for details

- EIS Test for Large-capacity Batteries (Single & Cycle test)
- Battery Consistency Screening (Abnormal Battery Screening)
- SOH Rapid Estimation (Cascade Utilization)
- Battery Failure Analysis (Production Problem Troubleshooting)

Model Table

	Battery Impedance Tester	Adjustable Prismatic Battery Test Bracket	Adjustable Cylindrical Battery Test Bracket
Physical picture			
Model	BIT6000	APTB1000	ACTB1000
Voltage control accuracy	±0.006% F.S.	Applicable to all kinds of prismatic batteries Maximum length*width*height 284*94*255 mm Maximum tab spacing 40 ~ 240 mm (Other sizes can be customized)	Applicable to cylindrical batteries18650/21700, etc. Maximum length 130 mm Diameter range 18 ~ 50 mm (Other sizes can be customized)
Current control accuracy	±0.05% F.S.		
EIS frequency range	1500Hz ~ 0.1Hz		
EIS test range	0.05mΩ ~ 100mΩ		
Applicable battery capacity	2~1000A lithium-ion battery		

Note: IEST prioritizes continuous product updates, and our specifications are subject to change without prior notice.

Background

Key Challenges in Battery Manufacturing & Recycling:

Q1:As battery capacity increases, internal resistance decreases. However, traditional electrochemical workstations fail to perform effective testing and they are expensive if used with current amplifiers;

Q2: Different batteries can' t be distinguished by OCV or 1000Hz ACIR alone. How can batteries be precisely categorized based on their electrochemical characteristics?

Q3:If there is an abnormality in the battery, how can we quickly locate the production problem? Is it a poor welding? Or a poor formation? Or is it a material failure?

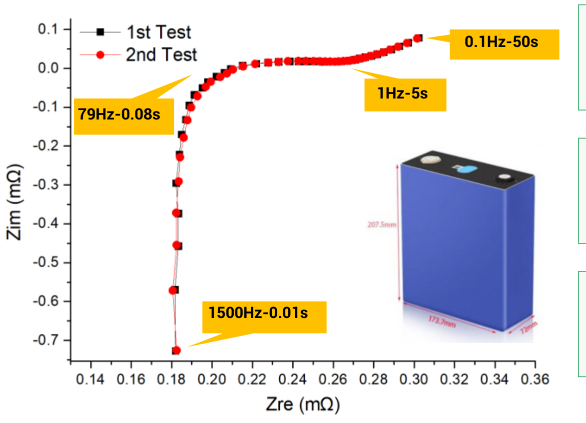
Q4:How to judge the consistency of the battery before assembling the battery module? OCV or 1000Hz ACIR alone can no longer meet the requirements;

Q5:Are there differences between the same type of batteries purchased from different manufacturers? Can they be mixed?

Q6:How much SOH is left for recycled or disassembled batteries? How to perform cascade utilization?

EIS test of battery with large capacity & low internal resistance

EIS Test for 280Ah LFP Battery (1500 Hz~0.1 Hz)

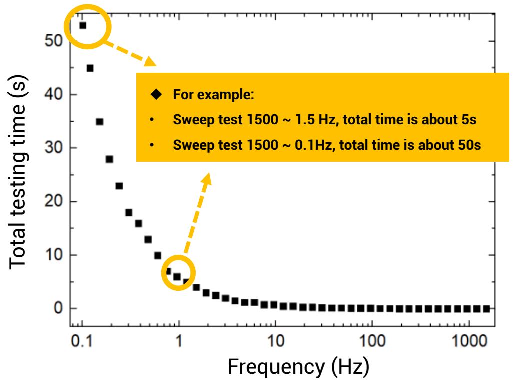


Easily test EIS of batteries with large capacity and low internal resistance

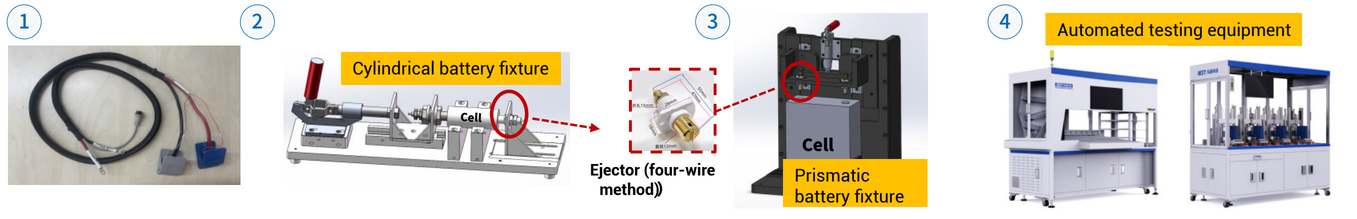
Fast EIS test, 1Hz impedance only takes 5 seconds

Can be used with various fixtures and automation equipment

Frequency vs. Total Test Time

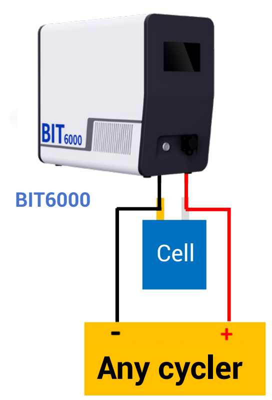


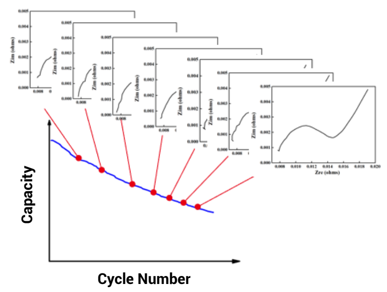
Support customization of various test lines or fixtures

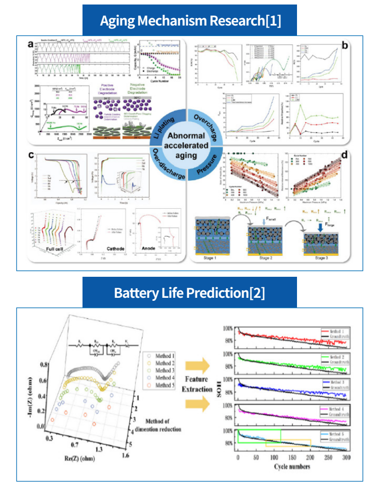


The EIS test frequency range can be adjusted according to the production line progress and process section

EIS test during battery cycling





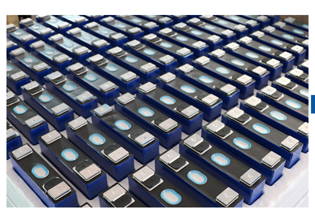


Eliminates manual intervention between "temperature adjustment ⇔ charge and discharge instrument ⇔ electrochemical workstation" by automating temperature control and EIS testing workflows.

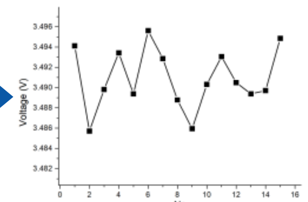
[1] J. Phys. Chem. C, 127 4465-4495 (2023);
[2] J. Power Sources, 576 233139 (2023);

Battery consistency screening (abnormal battery screening)

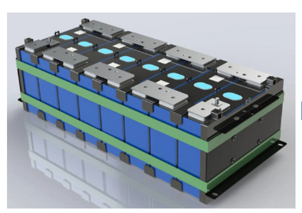
Traditional battery sorting method



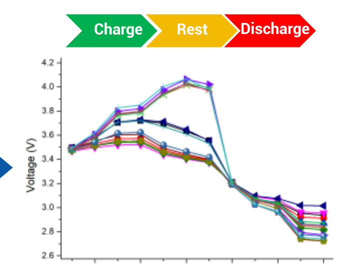
A batch of batteries "to be used"



Choose batteries with consistent "OCV"



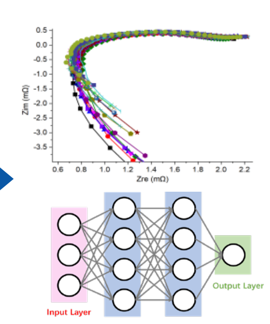
Assemble into battery module



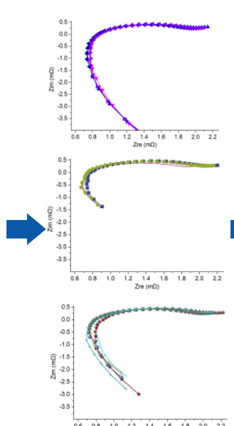
Unable to solve the problem of inconsistent charging and discharging

IEST's battery sorting method

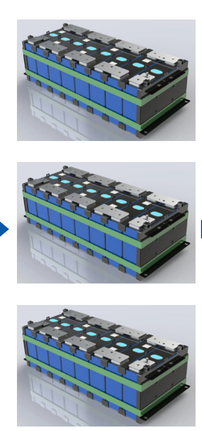
A batch of batteries "to be used"



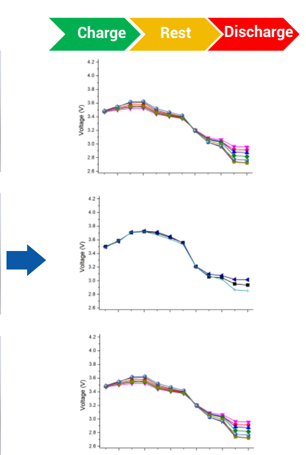
Test the EIS curves and classify it using a neural network algorithm



Choose batteries with consistent "EIS"



Assemble into battery module



Ensure the consistency of batteries in the module

AI-Driven SOH Estimation via Cascade Optimization

Traditional battery sorting and cascade utilization:

1. A batch of recycled batteries
2. Charge and discharge the batteries
3. Grouping and tiered utilization based on capacity

Three major disadvantages:

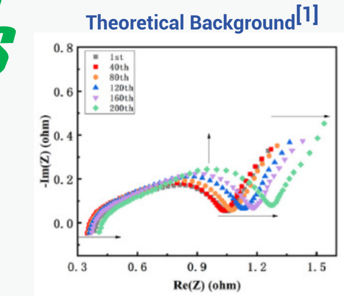
- Long grading time
- High power consumption
- Many channels occupied

VS

IEST's rapid sorting solution:

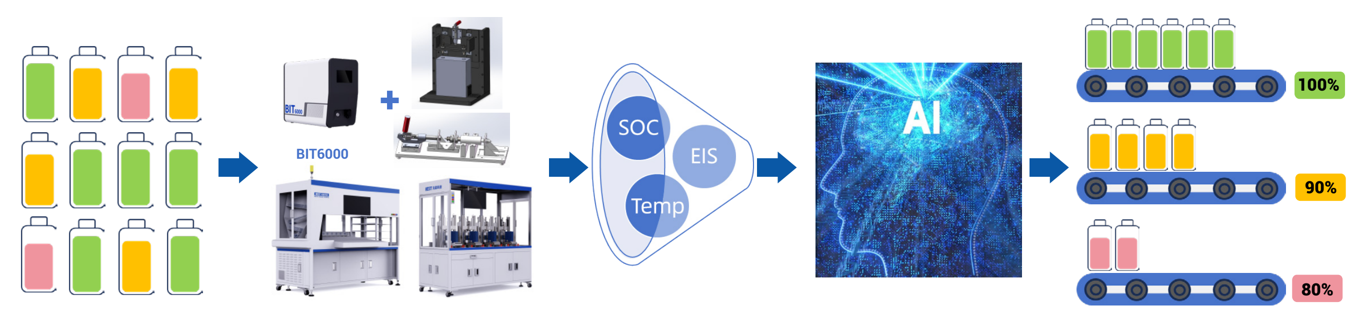
1. A batch of recycled batteries
2. Perform EIS test on the batteries
3. According to the correlation model between EIS and capacity, conduct rapid capacity division

Theoretical Background[1]



[1] J. Power Sources, 576 233139 (2023);

Battery health (SOH) degradation directly correlates with EIS parameter variations.



A batch of recycled batteries (different SOH)

SOH rapid prediction model based on EIS test

SOH estimation accuracy <5% (big data modeling required)

Applications:

Battery Recycling & Cascade Utilization

Battery Pack After-Sales Outlets

Used Car Recycling

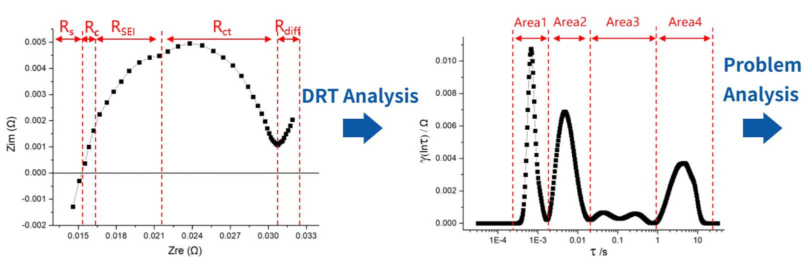
Battery cell failure analysis (Root Cause Identification & Mitigation)

Distribution of Relaxation Times (DRT) analysis is a mathematical method for analyzing EIS spectra. Different from conventional equivalent circuit fitting, DRT analysis can avoid various problems such as

① the fitting model depends on the initial value;

② the fitting result is distorted;

③ different models can be fitted, but the mechanism explanation is not unified.



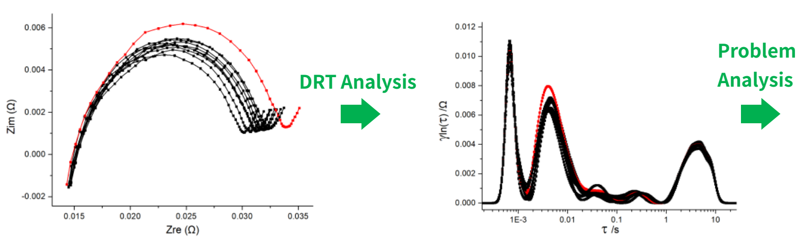
Contact impedance R_c : The sum of all electronic resistances inside the battery, which is related to various problems

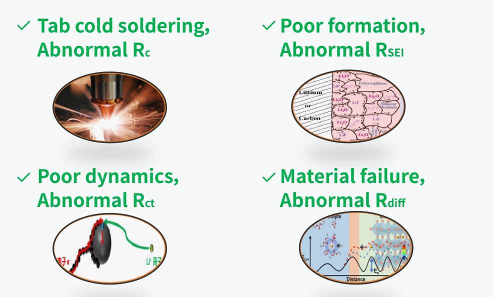
Contact impedance R_c ⇔ Area1 : problems such as poor soldering of the tab and poor contact

SEI film impedance R_{SEI} ⇔ Area2 : problems such as poor formation folding and wrinkling of the electrode

Charge transfer impedance R_{ct} ⇔ Area3 : problems such as poor interface dynamics and lithium precipitation

Ion diffusion impedance R_{diff} ⇔ Area4 : problems such as poor electrode compaction and poor electrolyte infiltration





Coin-cell Automatic Assembly System

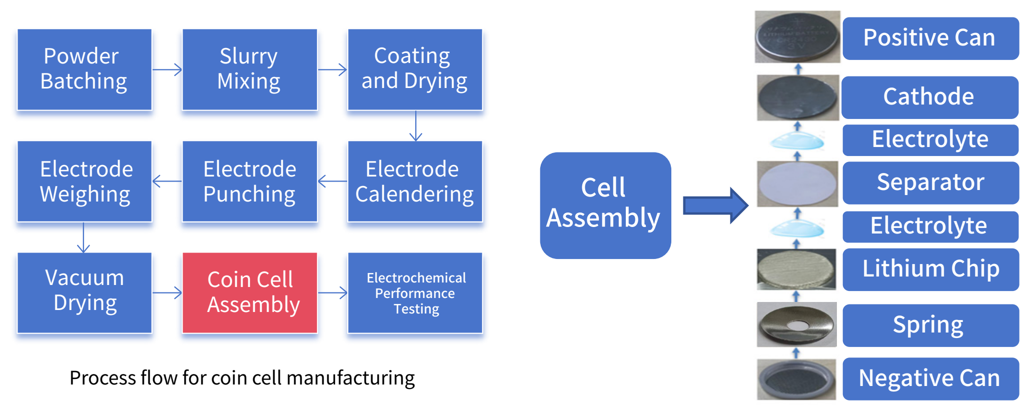
Scan QR code for details

Model Table

Model	CAAS1000	CAAS1000G/M	CAAS1100G/M	CAAS1200G/M
Picture				
Batch Assembly Capacity	1~10ea	1~10ea	40ea	200ea
Assembly Accuracy	±0.4mm	±0.2mm		
Assembly Efficiency	2min/ea	1~1.5min/ea		
Assembly Efficiency	• Compatible with customer standard glove boxes • Modular robotic arm • Vision detection and positioning system • Automatic sealing machine • Automatic Electrolyte dispensing	• Compatible with customer standard glove boxes • Modular robotic arm • Vision detection and positioning system • Automatic sealing machine • Automatic Electrolyte dispensing	• Integrated double-sided four-station glove box • High-precision robotic arm • High-throughput assembly • Vision detection and positioning system • Automatic sealing machine • Automatic Electrolyte dispensing • Multi-module function options	

The Significance of Coin Cells

In the preliminary stages of lithium battery R&D for novel materials and fabrication processes, coin cells serve as essential platforms for fundamental electrochemical validation. The precision in cell assembly directly impacts the reliability of performance metrics (e.g., capacity retention, cycle stability) and determines the bench-scale feasibility of materials for commercial applications.



Process flow for coin cell manufacturing

Pain Points Solved

- Enhance Assembly Consistency
- End-to-End Traceability
- Cut Labor Costs
- High-Throughput Assembly
- Reduce Repetitive Labor

Product Introduction

Automatic Coin Cell Assembly

Equipment Features: High-precision robotic arm + AI vision inspection + Automatic sealing device + High assembly throughput + Full-process traceability, enabling automated, high-precision assembly.

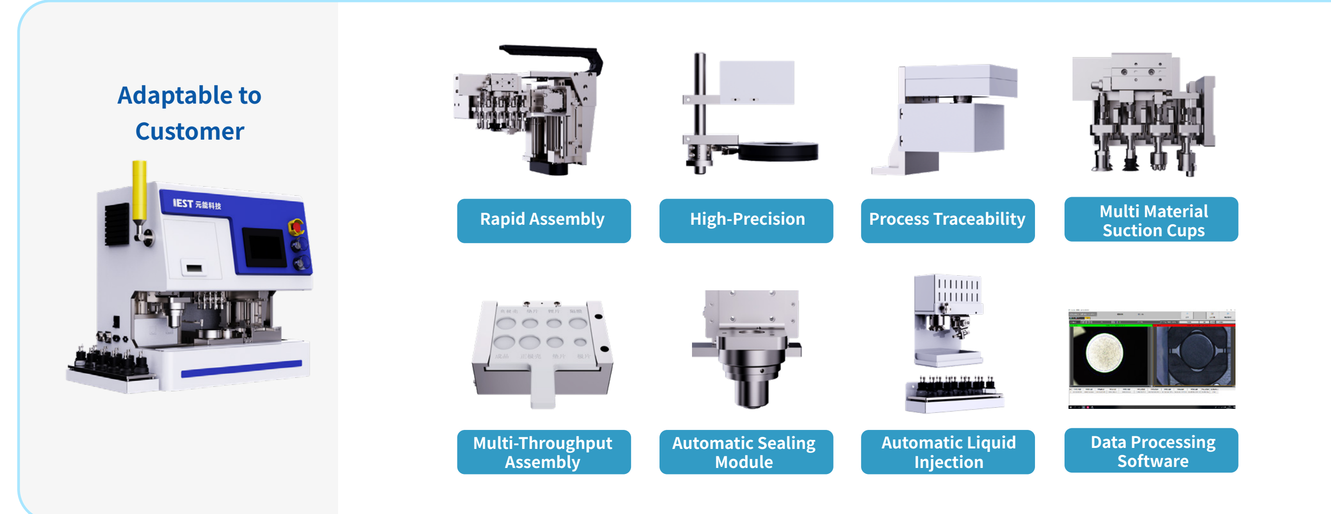
Application Scenario: Automated coin cell assembly — for systematic evaluation of the electrochemical performance of lithium/sodium battery cathode

Automatic Coin Cell Assembly System CAAS (Compact Version)

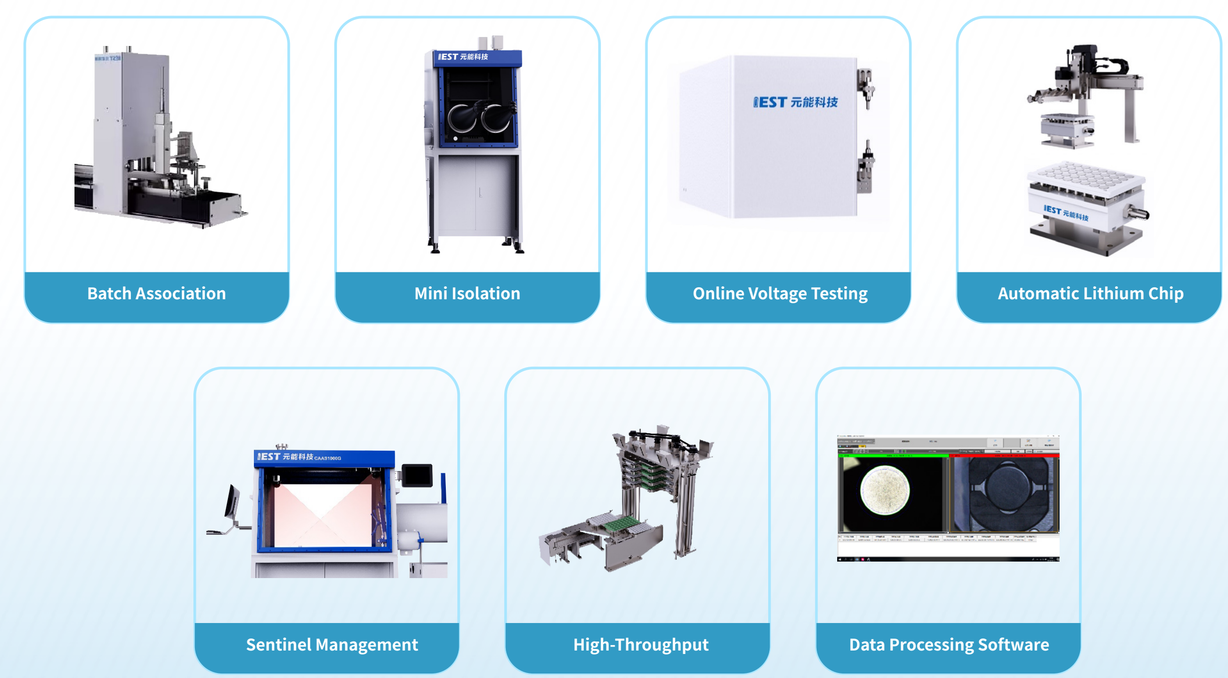
Equipment Feature: Compatible with standard single-station, single-sided gloveboxes; integrates automatic electrolyte injection, automatic sealing, CCD positioning system, multi-station suction cups, etc.; Assembly throughput is customizable: 1-10 ea.

Application Scenario: Suitable for universities, research institutes requiring small-batch assembly of lithium/sodium-ion coin cells for testing purposes.

Main Functions



Optional Features

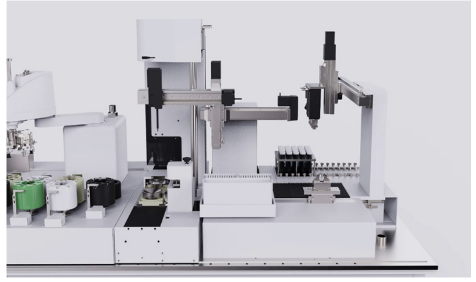


Equipment Expansion

High-Throughput Automatic Electrolyte Switching System

Equipment Features: Can interface with an automatic electrolyte formulation platform. The system enables automatic switching between 100 different electrolyte recipes, supports continuous assembly of 400 battery cells.

Application Scenario: Suitable for coin cell assembly for electrolyte formulation verification and high-throughput battery assembly.

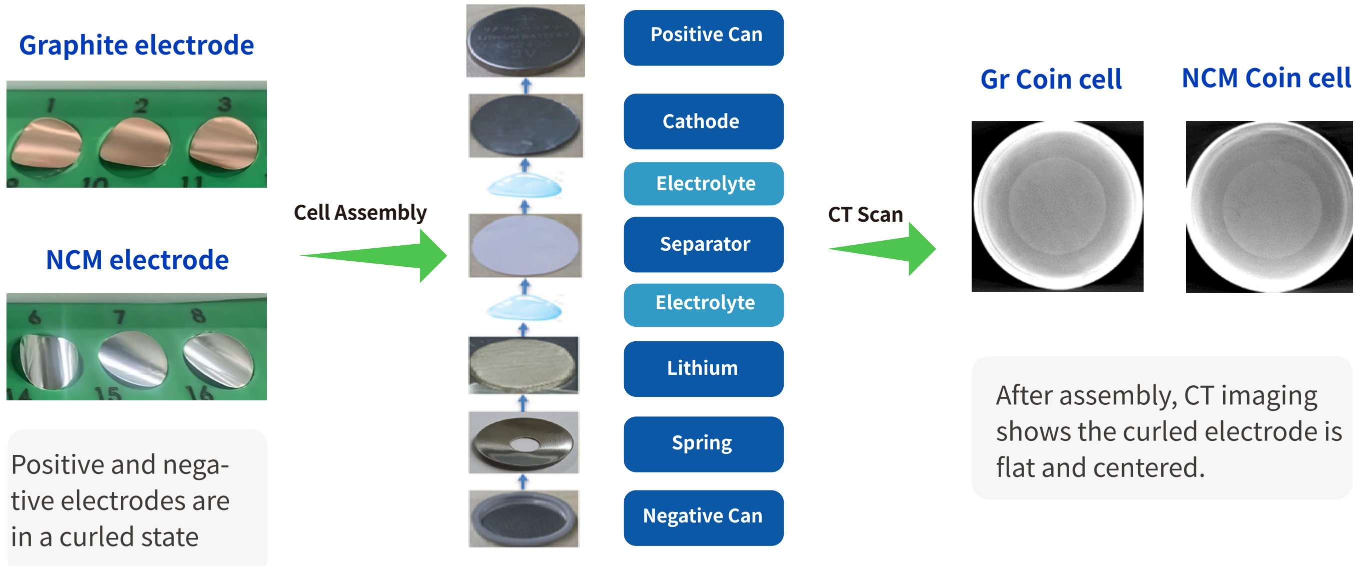


Liquid Injection Module

- High-precision liquid injection system with an accuracy of ±1 μL. Injection volume for a single cell is
- continuously adjustable from 0 to 200 μL.
- The injection tips can be automatically switched to prevent cross-contamination of electrolytes.

Application Cases

Case 1: Curling Issue of Single-Sided Electrodes after Calendering and Punching



Positive and negative electrodes are in a curled state

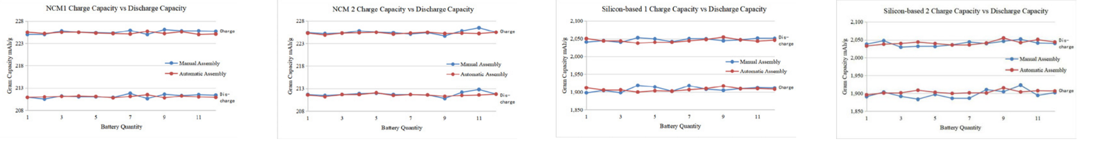
After assembly, CT imaging shows the curled electrode is flat and centered.

Due to the curling of single-sided electrodes after calendering, the automatic assembly equipment ensures that the curled electrode remains flat and centered upon insertion into the casing through specialized assembly processes and a visual positioning system. This guarantees consistency in battery assembly.

Case 2: Comparison of Manual & Automatic Assembly

Assembly Comparison		Manual Assembly			Automatic Assembly		
Item		Charge capacity (mAh/g)	Discharge capacity (mAh/g)	Efficiency (%)	Charge capacity (mAh/g)	Discharge capacity (mAh/g)	Efficiency (%)
NCM-1	Range value	1.1	1.3	0.22%	0.7	0.7	0.26%
	Averange	225.525	211.142	93.62%	225.325	211.05	93.66%
	σ	0.384	0.396	0.001	0.226	0.198	0.001
	COV	0.17%	0.19%	0.07%	0.10%	0.09%	0.08%
NCM-2	Range value	1.8	2	0.23%	0.6	0.9	0.23%
	Averange	225.467	211.7833	93.93%	225.292	211.6083	93.93%
	σ	0.44	0.465	0.001	0.178	0.231	0.001
	COV	0.20%	0.22%	0.07%	0.08%	0.11%	0.07%

Assembly Comparison		Manual Assembly			Automatic Assembly		
Item		Charge capacity (mAh/g)	Discharge capacity (mAh/g)	Efficiency (%)	Charge capacity (mAh/g)	Discharge capacity (mAh/g)	Efficiency (%)
Silicon base-1	Range value	20.6	12.6	0.55%	17	16.8	0.25%
	Averange	1908.4	2046.9083	93.24%	1907.592	2044.9083	93.28%
	σ	6.948	4.391	0.002	4.553	4.678	0.001
	COV	0.36%	0.21%	0.18%	0.24%	0.23%	0.07%
Silicon base-2	Range value	39.7	22.4	1.46%	19.9	22.2	0.38%
	Averange	1897.85	2039.7833	93.02%	1903.992	2041.5667	93.26%
	σ	11.669	6.954	0.005	5.211	6.322	0.001
	COV	0.61%	0.34%	0.49%	0.27%	0.31%	0.11%

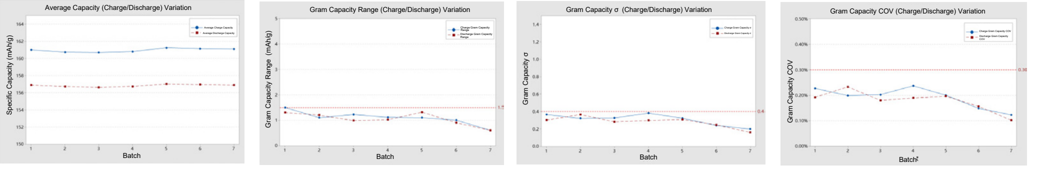


Summary

- The range of charge/discharge specific capacity for NCM with automatic assembly is 0.6~0.9 mAh/g (σ ≈ 0.25), while with manual assembly it is 1~2 mAh/g (σ ≈ 0.4).
- The range of charge/discharge specific capacity for Si-based materials with automatic assembly is 15~20 mAh/g (σ ≈ 4~6), while with manual assembly it is 20~40 mAh/g (σ ≈ 5~10).
- The average coin cell specific capacity is similar between automatic and manual assembly, but the data stability of automatic assembly is superior to that of manual assembly.

Case 3: Automatic Coin Cell Assembly of LFP Cathodes

Category	Item	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Range	Charge capacity (mAh/g)	1.5	1.1	1.2	1.1	1	0.6	0.4
	Discharge capacity (mAh/g)	1.3	1.2	1	1.3	0.9	0.6	0.5
	Coulombic Effi (%)	0.8	0.4	0.3	1.3	0.4	0.5	0.6
Average	Charge capacity (mAh/g)	161	160.7	160.7	161.3	161.1	161.1	161.1
	Discharge capacity (mAh/g)	156.9	156.7	156.6	157	156.9	156.9	156.9
	Coulombic Effi (%)	97.4	97.5	97.5	97.4	97.4	97.4	97.4
σ	Charge capacity (mAh/g)	0.37	0.32	0.33	0.38	0.24	0.2	0.12
	Discharge capacity (mAh/g)	0.31	0.36	0.29	0.3	0.25	0.16	0.12
	Coulombic Effi (%)	0.18	0.12	0.09	0.3	0.11	0.12	0.12
COV	Charge capacity (mAh/g)	0.23%	0.20%	0.21%	0.24%	0.15%	0.12%	0.10%
	Discharge capacity (mAh/g)	0.20%	0.23%	0.18%	0.19%	0.16%	0.10%	0.10%
	Coulombic Effi (%)	0.18%	0.12%	0.09%	0.31%	0.11%	0.12%	0.12%

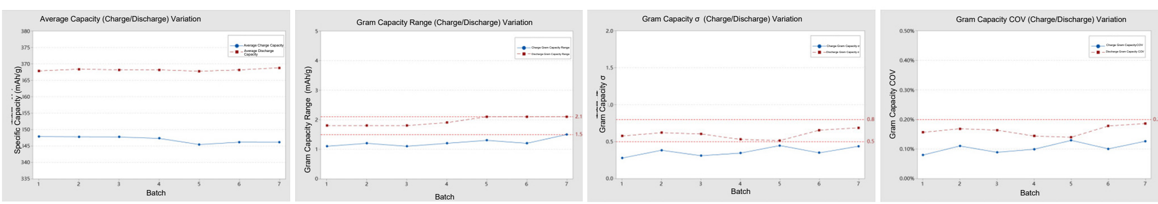


Summary

- The standard deviation (σ) for the charge/discharge specific capacity of each group is less than 0.4.
- The range for the charge/discharge specific capacity of each group is less than 1.5 mAh/g.
- The coefficient of variation (COV) for the charge/discharge specific capacity of each group is less than 0.3%.

Case 4: Automatic Coin Cell Assembly of Graphite Anodes

Category	Item	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Range	Charge capacity (mAh/g)	1.1	1.2	1.1	1.2	1.3	1.2	1.5
	Discharge capacity (mAh/g)	1.8	1.8	1.8	1.9	2.1	2.1	2.1
	Coulombic Effi (%)	0.4	0.5	0.5	0.4	0.5	0.7	0.6
Average	Charge capacity (mAh/g)	347.9	347.8	347.7	347.3	345.4	346.2	346.1
	Discharge capacity (mAh/g)	367.8	368.4	368.2	368.2	367.7	368.2	368.8
	Coulombic Effi (%)	94.6	94.4	94.4	94.3	93.9	94	93.8
σ	Charge capacity (mAh/g)	0.28	0.38	0.31	0.34	0.45	0.35	0.44
	Discharge capacity (mAh/g)	0.57	0.62	0.6	0.53	0.51	0.65	0.69
	Coulombic Effi (%)	0.13	0.15	0.14	0.13	0.13	0.17	0.15
COV	Charge capacity (mAh/g)	0.08%	0.11%	0.09%	0.10%	0.13%	0.10%	0.13%
	Discharge capacity (mAh/g)	0.16%	0.17%	0.16%	0.14%	0.14%	0.18%	0.19%
	Coulombic Effi (%)	0.14%	0.16%	0.15%	0.13%	0.14%	0.18%	0.16%



Summary

- The standard deviation (σ) for the discharge specific capacity in each group is less than 0.8, and for the charge specific capacity, it is less than 0.5.
- The range for the discharge specific capacity in each group is less than 2.1 mAh/g, and for the charge specific capacity, it is less than 1.5 mAh/g.
- The coefficient of variation (COV) for both charge and discharge specific capacity in each group is less than 0.2%.

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