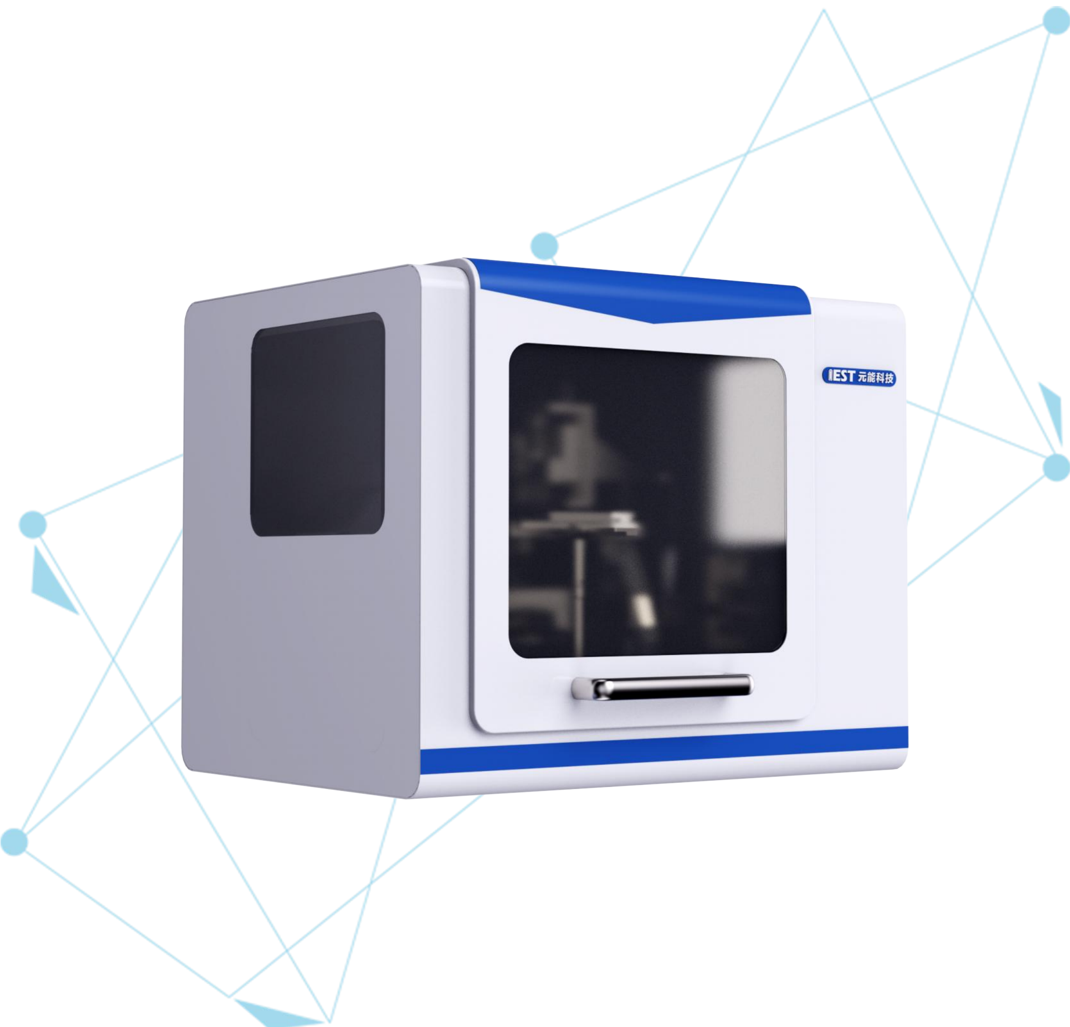
DEDICATED TO LITHIUM-ION BATTERY TESTING AND DEVELOPMENT

IEST®

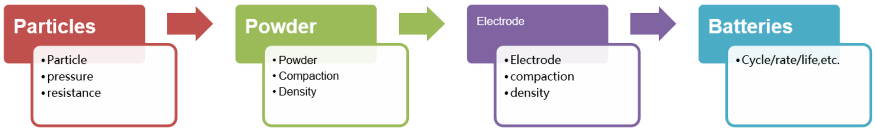


Single Particle Force Properties Test System

SPFT

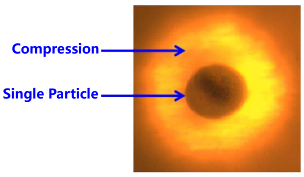
Product Introduction

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

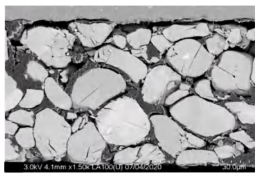


Testing Object: Lithium battery positive and negative electrode materials(Positive : polycrystalline ternary, lithium-rich material; Negative: silicon-based, hard carbon, etc.; solid electrolyte)

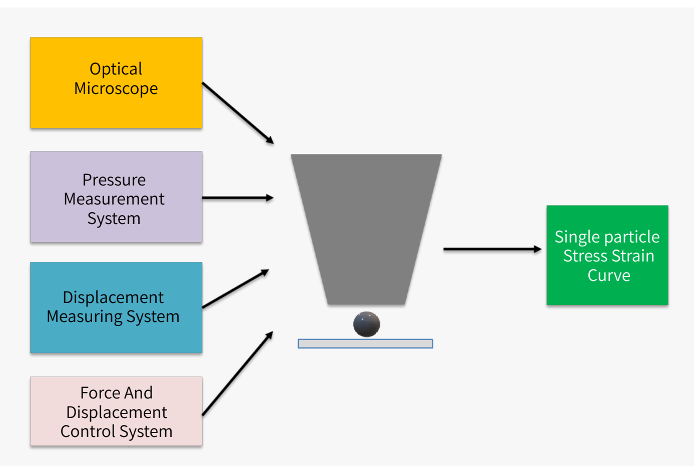
Test Particle Size: single particle size: 5~50 um



Single Particle Compression (Bottom View)


Cracking after Particle Circulation (SEM Image)

Equipment Composition



Basic Functions

Particle Squeezing
Recording force-displacement curve - looking for the "failure" point: force at which the particles are crushed (failure).

Functional Modules

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

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

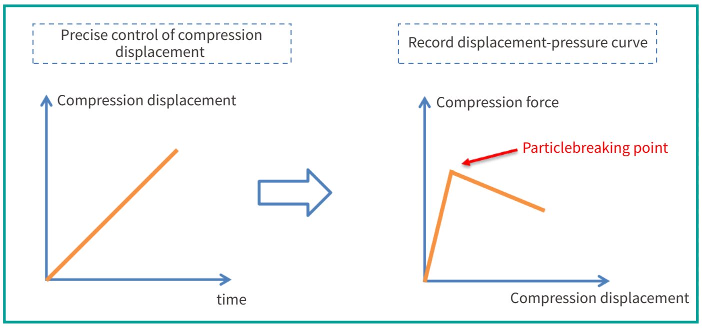
Testing Program

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

Test Parameters:

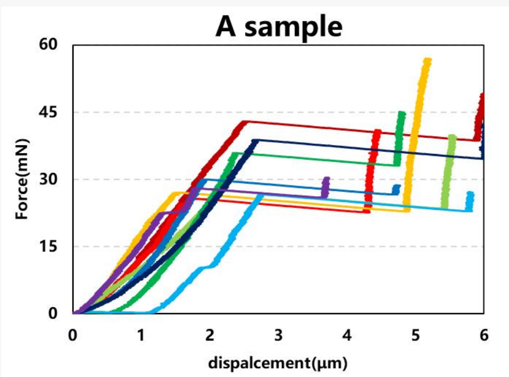
Magnification: up to 1200 times;
Pressure test range: 0-100 mN;
Pressure test accuracy: ±0.1 mN;
Minimum displacement unit: 10nm;
Data collection frequency 1000HZ;

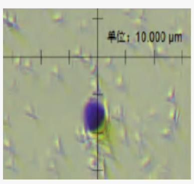
Comply with national standard GB/T 43091-2023 "Powder Compressive Strength Test Method"

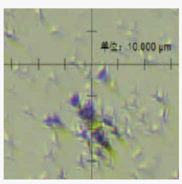


Application Case

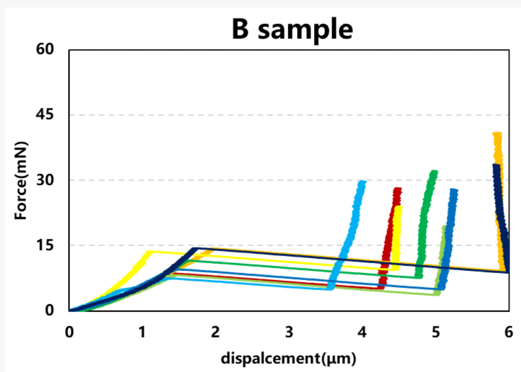
Anode Material——SiC

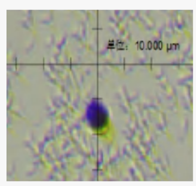


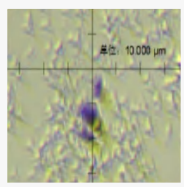




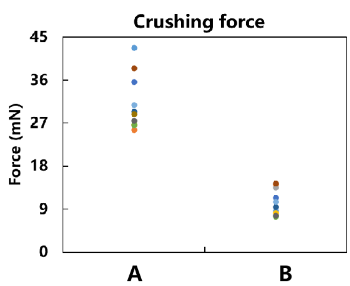
Before Crushing After Crushing





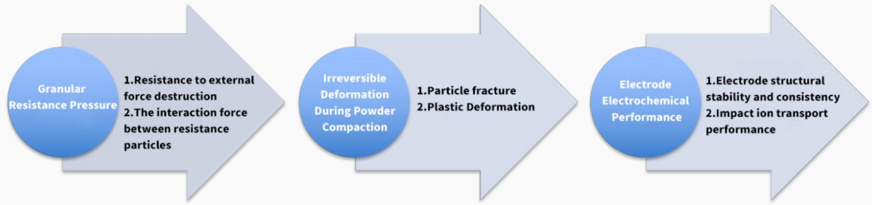


Before Crushing After Crushing

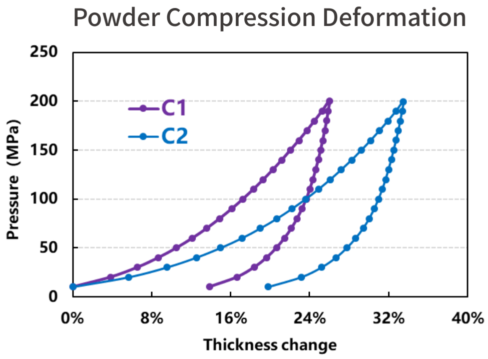


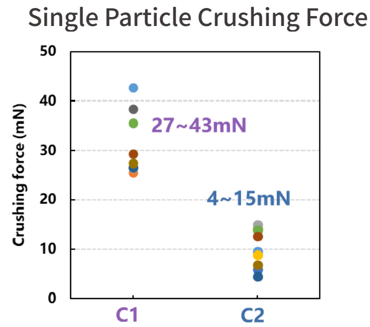
1. Two silicon-carbon materials with different electrode compaction;
2. Comparison of crushing force distribution: A>B.
3. Analysis of stress-displacement curves: Sample A exhibits initial micro-cracking followed by complete collapse, while sample B experiences direct structural collapse and fragmentation.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

Particle Compression Resistance and Powder Compaction



Case 1: Two Different Pure Carbons

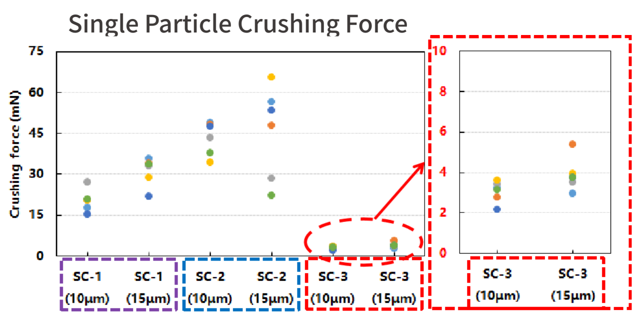




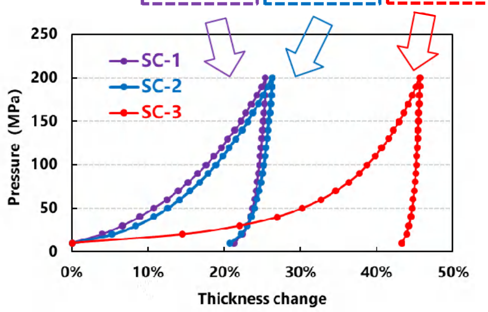
Material	Irreversible Deformation Parameter	Maximum Deformation Value
C1	13.8%	26.0%
C2	19.8%	33.5%

The compressive resistance of particle level C1 is stronger. Corresponding to the powder end, C1 has a higher compression modulus than C2, with both maximum deformation and irreversible deformation smaller than C2.

Case 2: Three Different Carbon-Silicon Materials



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

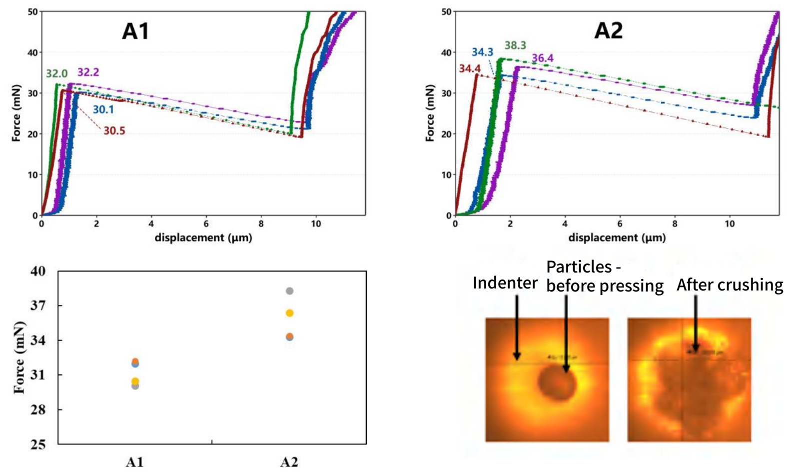


Powder Compression Deformation

SC-3 has weaker compressive strength of its particles, resulting in significantly larger maximum deformation and irreversible deformation when the powder is compressed compared to the other two materials.

Ternary Cathode Material——NCM811

Case 1

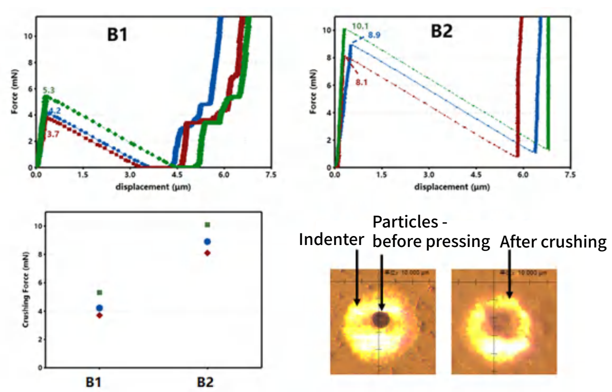


1. Two ternary materials A1 and A2 are sintered from the same precursor, but the sintering process is different. The particle size D50 is 18 μm.

2. The compression resistance of A2 is better than that of A1, and changing the sintering process can improve the material hardness to a certain extent. Single particle mechanical property characterization methods can provide guidance for the sintering process of materials.

Case 2

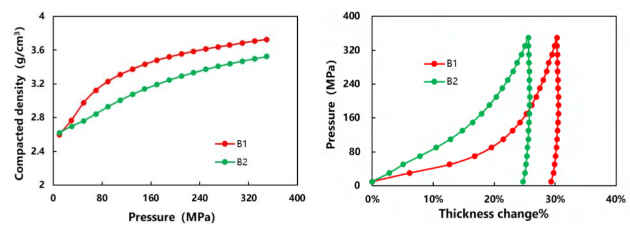
Single Particle Testing



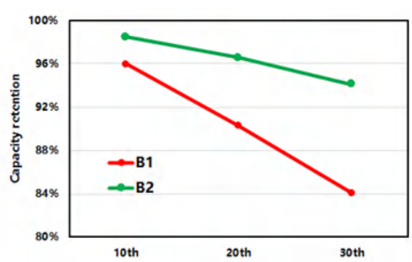
1. Two ternary materials, B1 and B2, are sintered from different precursors, and the particle size D50 is both 9.5 μm;

2. The phenomena during particle crushing differ; powder compaction varies; discharge cycling performance differs.

Powder Testing



Discharge Testing



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

Model Comparison

Device name	Single particle crush strength tester	
Device model	SPFT1000	SPFT2000
Test parameters	Displacement, pressure	
Test range	Displacement：0-80μm；Pressure：0-100mN	
Test accuracy	Displacement resolution：1nm；Pressure resolution：0.1mN	
Stress-displacement curve	•	•
Particle image observation	•	•
Automatic displacement platform	/	•
Automatic pressure control	•	•
Fully automatic software	•	•

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