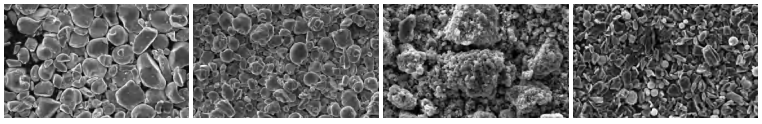
POWDER COMPACTION DENSITY MEASUREMENTSYSTEM

PCD2000



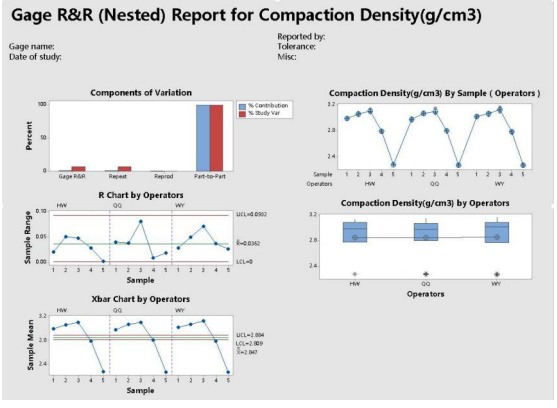
1. Background

The compaction density of the powder materials is not only related to its particle size and distribution, but also closely effect the capacity, internal resistance and the cycling performance of the produced lithium-ion batteries (LIBs). Theoretically speaking, the higher the compaction density, the higher the capacity of the LIB can be. Therefore, the compaction density is used as one of the key indicators to evaluating the energy density of materials. The compaction density is closely related to the intercalation and deintercalation of lithium ions during the cycling. Appropriate compaction density can effectively increase the capacity of the LIB reduce internal resistance, reduce polarization loss, and prolong the overall service life of the battery. On the one hand, the measurement of powder compaction density can be used as an effective index to monitor the differences between batches of powder materials, and on the other hand, it can be used as an effective means of R&D material evaluation and process optimization.

2. Creative Solution

- The integrated design of the pressure application and thickness measurement modules can measure the compaction density under different quantitative pressures in real time;
- Fully automatic measurement software system, multi-parameter synchronous acquisition, intelligent and efficient testing process;
- Various testing modes such as single point, variable pressure, pressurization, and pressure relief can be optional, and the performance of the powder material can be evaluated in an all-round way;
- Equipped with machine inspection standard parts, preprocessing equipment and automatic demoulding equipment to ensure stable testing and improve overall efficiency.

3. Measurement System Analysis (MSA)



Gage evaluation

Source	StdDev(SD)	(6×SD)	(%SV)
Meter included R&R	0.021956	0.13173	6.36
Repeatability	0.021956	0.13173	6.36
Reproducibility	0.000000	0.00000	0.00
Part-To-Part	0.344280	2.06568	99.80
Total Variation	0.344980	2.06988	100.00

Number of Distinct Categories = 22

Excellent

4. Application Cases

① Effective evaluation of the compaction density of positive and negative electrode powders and conductive materials of lithium-ion batteries;

② Monitor the long-term stability of the compaction density of the material;

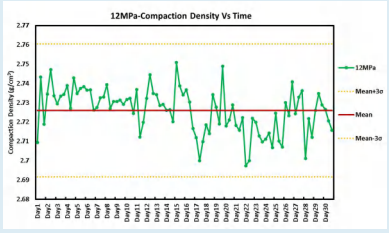
③ Realize the effective evaluation of material stress-strain performance;

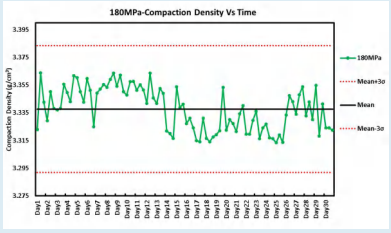
④ Realize the effective evaluation of material compression rebound performance;

Application Case - Long-term Stability Evaluation of Nickel Cobalt Manganese Materials

Test mode:

Multipoint mode





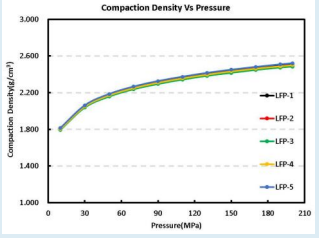
Parameters: 12MPa, 180MPa, hold pressure for 10s, test 3 groups every day, a total of 30 days of testing.
Result analysis: The results of compaction density in 30 days are all less than ±3σ, and the long-term stability of the compaction density of this sample is good.

Long-term stability of the compaction density of the sample can be monitored!

Application Case - Lithium Iron Phosphate Material Evaluation

Test mode:

Variable Pressure mode



Pressure (MPa)	Compaction Density (g/cm³)						
	LFP-1	LFP-2	LFP-3	LFP-4	LFP-5	Range	COV
10	1.813	1.802	1.795	1.803	1.816	0.0203	0.41%
30	2.059	2.048	2.038	2.050	2.062	0.0238	0.41%
50	2.182	2.167	2.158	2.172	2.186	0.0279	0.46%
70	2.261	2.248	2.237	2.251	2.266	0.0291	0.45%
90	2.319	2.306	2.295	2.310	2.326	0.0316	0.47%
110	2.368	2.354	2.342	2.357	2.374	0.0312	0.47%
130	2.409	2.396	2.383	2.398	2.415	0.0318	0.46%
150	2.443	2.430	2.417	2.433	2.450	0.0334	0.47%
170	2.474	2.458	2.448	2.464	2.480	0.0325	0.47%
190	2.499	2.485	2.473	2.489	2.508	0.0345	0.47%
200	2.510	2.498	2.485	2.502	2.520	0.0354	0.47%

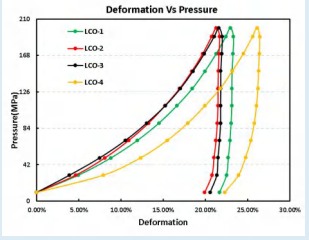
Parameters: 10-200MPa, sampling points at an interval of 20MPa, holding pressure for 10s, a total of 5 groups of tests.
Result analysis: The COV of the compaction density of 5 groups under each pressure is less than 0.5%, and the data fluctuation range is less than 0.05g/cm3, indicating that the the repeatability of this equipmentis good.

It can evaluate the real-time change trend of the compaction density of the material with the increase of the pressure!

Application Case-Lithium Cobalt Oxide Material Evaluation

Test mode:

Steady-state mode



Name	Reversible Deformation	Irreversible Deformation	Max Deformation
LCO-1	1.63%	21.67%	23.30%
LCO-2	1.76%	19.91%	21.67%
LCO-3	1.42%	20.55%	21.97%
LCO-4	4.15%	22.28%	26.43%

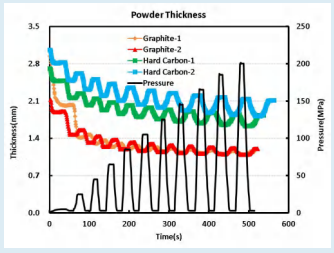
Parameters: 10-200MPa, sampling points at intervals of 20MPa, holding pressure for 10s, and tested 4 samples in total.
Result analysis: The results show that the stress-strain curves of the four lithium cobalt oxide materials are different during the compression process, and the compression properties of the materials can be further evaluated in combination with the material particle size distribution.

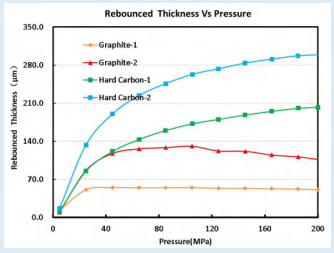
It can help R&D to evaluate the stress-strain performance of materials!

Application Case-Graphite and Carbon Material Evaluation

Test mode:

Pressure relief mode





Parameters: 10-200MPa, sampling points at intervals of 20MPa, hold pressure for 10s, release pressure to 3MPa, hold pressure for 10s, test 4 samples in total.

Result analysis: The results show that the thickness rebound of graphite and carbon materials during the process of pressurization and decompression are different, and the rebound of graphite material is greater than that of hard carbon.

It can help research and development to evaluate the compression rebound performance of materials!

5. Parameters and Installation Requirements

Model	PCD1000	PCD2000
Max pressure	1000kg	5000kg
Pressure measurement resolution / accuracy	0.1kg/±0.3%F.S	
Thickness measurement range	0-8mm	
Thickness measurement resolution / accuracy	0.5μm/±10μm	
Maximum capacity that can be filled	φ13*8mm (can be customized)	
Power supply	200~240V/50~60HZ	
Voltage variation tolerance	±10%	
Power	450W	2100W
Environment temperature	10~35℃,13mm*8mm(customizable)	
Environment humidity	< 80%RH (no condensation)	
Net weight	85kg	250kg
Size(W*D*H)	330*402*780mm (W*D*H)	370*565*1200mm (W*D*H)

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

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INITIAL ENERGY SCIENCE & TECHNOLOGY (XIAMEN) CO.,LTD
Address: Unit 426-430, Mani Square, No. 2 Huli Avenue, Huli District, Xiamen City
Tel：(86)592-5367060 Fax：(86)592-5367062
www.iestbattery.com E-mail：info@iesttech.com

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