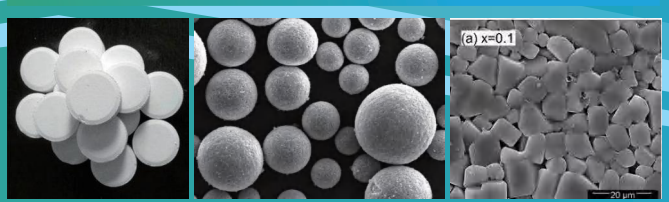
IEST®

SOLID ELECTROLYTE TEST SYSTEM

SEMS1100



—Dedicated to lithium-ion battery testing and development—

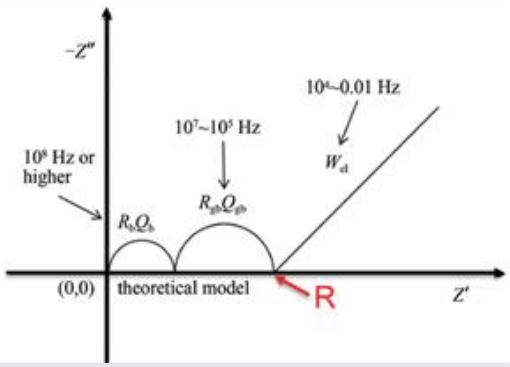
THE IMPORTANCE OF PERFORMANCE EVALUATION OF SOLID ELECTROLYTE AND LITHIUM METAL BATTERIES

Drivien by the rapid development of lithium industry,improving the energy density and security of batteries is an important research direction for lithium researchers.All-Solid-State battery is considered to be the most promising secondary battery with high security and high specific energy.To be more specific,solid electrolyte is the main core component(Solid Electrolyte ,abbreviated as “SE”as below). The main performance indexes is used to judge the performance of solid electrolyte are Ion-conductivity, Interfacial Stability of lithium metal and Full Battery Performance. On the one hand, the ensity roughness and integrity of the pressed solid electrolyte sheet determine the conductivity of the solid electrolyte and the performance of the whole battery cycle. On the other hand, steady and even application of force during the test ensures accurate results. Therefore, fabrication and testing systems that can apply stable and standardized pressure are critical for the development of solid electrolyte and lithium metal batteries.

SEVERAL SOLID-STATE ELECTROLYTE TEST METHODS

1 Ionic conductivity test method:

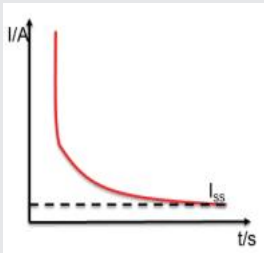
Ion-conductivity is the most important index to measure the ion transport performance of solid electrolyte, which is generally obtained by holding and measuring the electrochemical impedance spectrum (EIS) of its Sandwich ceramic plate with ion-blocking electrodes.Specific test method: using AC impedance method, and using the stainless steel as the ion block electrode, test samples of electrolyte in equilibrium under the condition of different frequency impedance changes, and then according to the equivalent circuit analysis to calculate theIon-conductivity, as shown in the following formula, which R for ion impedance of EIS curves, L is the thickness of the sample, S is the area of the sample.



$$\sigma=\frac{L}{S\times R}$$

2 Electronic conductivity test method:

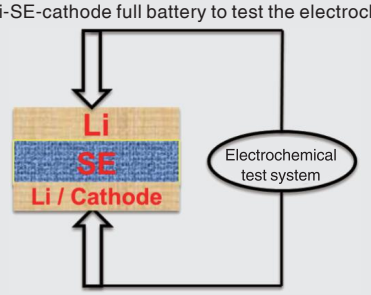
Electronic conductivity is the key index to evaluate the ability of solid electrolyte to isolate anode and cathode materials and prevent battery short circuit. It is generally obtained by clamping and measuring the DC polarization curve of its “ sandwich ceramic plate ”.Specific test methods: constant current polarization method and constant voltage polarization method. By applying constant current and constant voltage to the solid elecrolyte for acertain period of time, the voltage or current at both ends of the polarized electrolyte is measured and the conductivity σis caluated according to Ohm ’ s Law. In the following formula, Iss is the steady-state current under constant voltage, U is the applied constant voltage, L is the thickness of the sample ,and S is the area of the sample.



$$\sigma=\frac{I_{SS}}{U}\times\frac{L}{S}$$

3 Electrochemical performance test method:

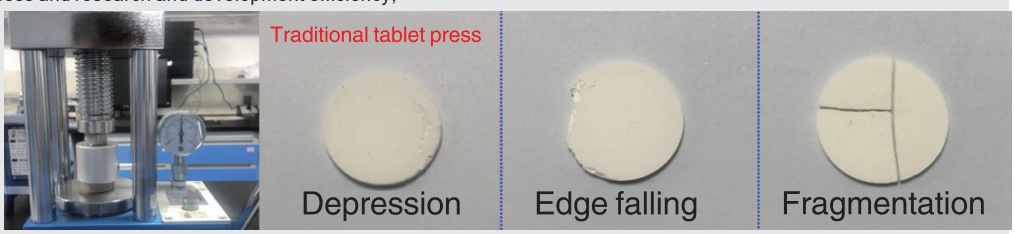
Lithium-metal solid-state batteries usually need to evaluate the interface stability and the cycle performance of the whole battery.The sealed mold is assembled into a Li-SE-Li symmetrical battery or a Li-SE-cathode full battery to test the electrochemical performance.



LIMITATIONS OF TRADITIONAL PRODUCTION AND TRADITIONAL TESTING

1 Tablet compressingprocess:

Traditional production generally use manual press for solid electrolyte powder pressure production, the force is uneven, force instability, and it is easy to cause ceramic chip fragmentation or edge incomplete production phenomenon, at the same time the pressure and discharge process is longer, seriously affect the experimental process and research and development efficiency;



2 Test process:

The traditional test method generally adopts simple way of holding ceramic measurement, force, force size is limited, and the pressure cannot be quantified and maintained in a fixed value, for samples with different thickness, area and roughness, the force will have big differences, cannot be normalized and standardized, measurement results poor consistency, low reproducibility;

3 Conditional exploration:

Traditional clips or tooling cannot provide uniform, stable, and varying pressure for solid electrolyte sheet preparation or test condition exploration.

4 Measurement mode:

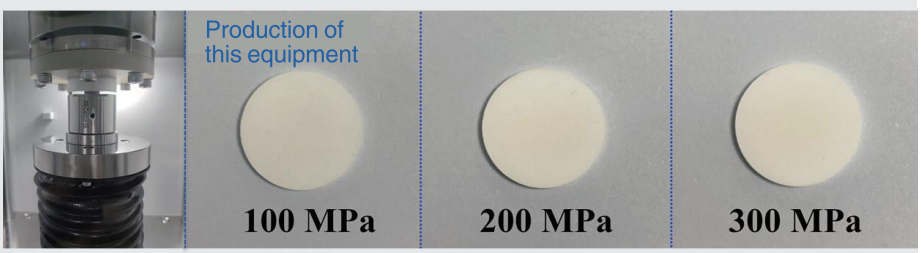
Only constant pressure, no quantitative pressure, force range is small, force is unstable during the test

CREATIVE SOLUTIONS

IEST together with Xiamen University, pioneered a multi-functional testing system for solid electrolyte samples, and an automatic measuring equipment for electron / ion conductivity integrating pressure plate, test and calculation.The system adopts an integrated design, including compression module, electrochemical test module, density measurement module, ceramic sheet pressing and clamp module, which can realize the following functions:

1 Press process

The production and test system that can apply 3~350 MPa fixed pressure can be adjusted in real time, and the force surface is uniform and stable. Combined with automatic stripping equipment can ensure the integrity of the ceramic sheet and improve the preparation success rate.



2 Test process

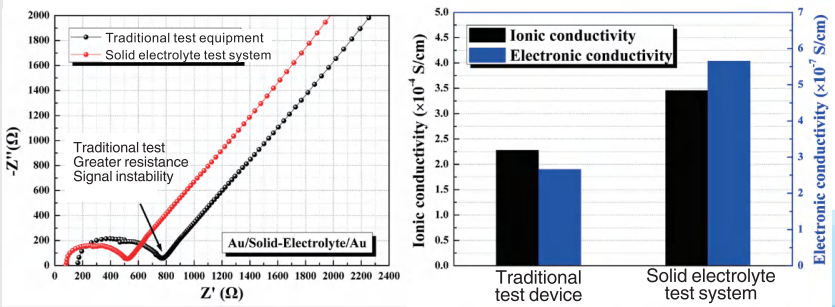
Provide standardized pressure conditions for sintering or gold / silver injection samples, so that the samples can conduct synchronous electrochemical tests under different quantitative pressure conditions to ensure the consistency of data measurement;

3 Conditions exploration

The equipment can provide uniform changes of the standard test pressure, used for solid electrolyte sheet preparation or test condition exploration;

4 Measurement mode

A variety of measurement modes-constant pressure and constant gap (the dynamic change of measurement stress), quantifiable pressure, force application range is large, controllable, uniform and stable force during the test process;



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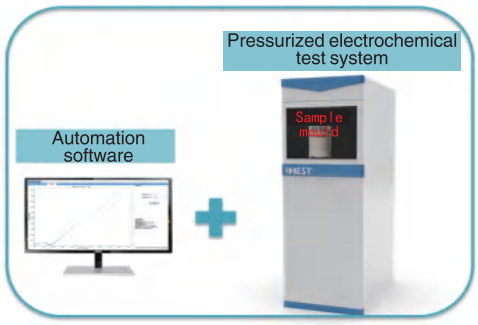
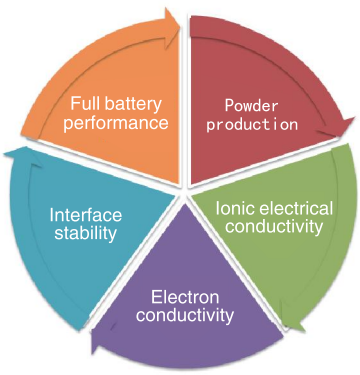
Instrument composition

Solid electrolyte integrated test system

（Automatic measurement of various electrochemical parameters can be realized）

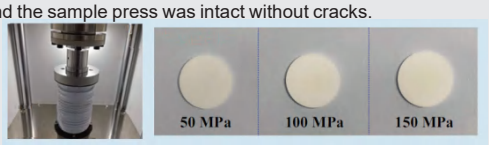


Application



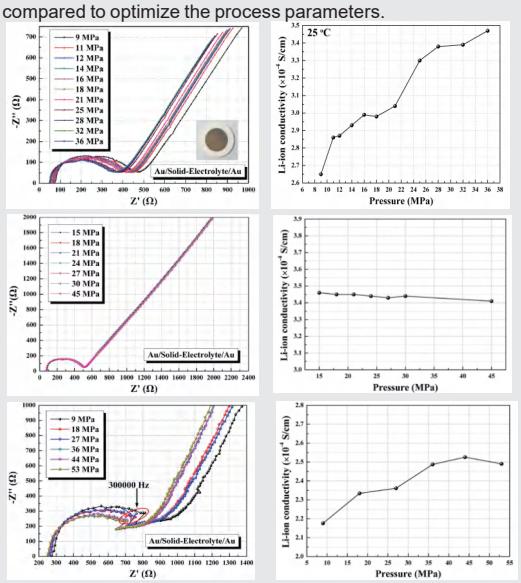
1 Powder production

The powder samples were produced under different pressure conditions, and the sample press was intact without cracks.



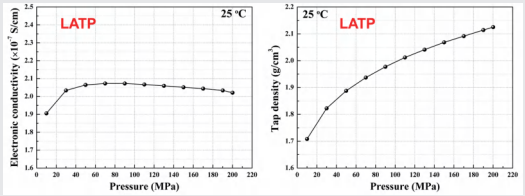
2 Ionic electrical conductivity

The ionic conductivity of the solid electrolyte of different systems can be tested, and the results of different test pressure conditions can be compared to optimize the process parameters.



3 Electron conductivity and compaction density

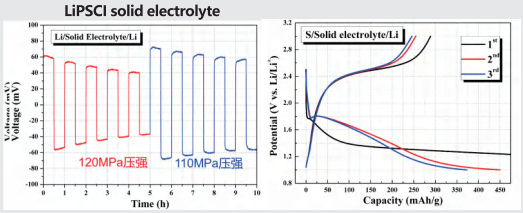
Different test pressures can be applied to the solid electrolyte in the powder state, and the change trend of the electron conductivity and compaction density can be measured simultaneously.



4 Interface stability

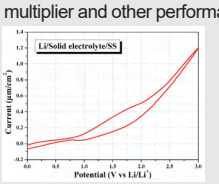
The interface overpotential of the electrolyte and the lithium electrode was assessed by using different test pressures for the Li / SE / Li battery.

LiPSCl solid electrolyte



5 Full battery performance

Using a sealed mold to assemble the Li-SE-S full battery for cycle testing, it can further analyze the first Koulomen efficiency, capacity retention rate, multiplier and other performance of the all-solid-state battery.



Main instrument parameters

Pressure measurement range	3~350MPa
Pressure accuracy	± 0.3%FS
Thickness measurement range	0-8mm
Thickness resolution / precision	0.5 m / ± 5 m
Sample die diameter	13mm, 16mm, 20mm (customized other diameter)
Temperature and humidity measurement range	0~50℃, 20-90%RH
Temperature and humidity measurement accuracy	± 2℃, ± 5%RH

Installation requirements

Voltage	220V
Voltage variation tolerance	±10%
Power dissipation	2100W
Environmental temperature	25±5℃
Environmental humidity	≤80%RH
Environmental magnetic field	Keep away from intense electromagnetic
Net weight	165Kg
Dimension(W*D*H)	370*580*1100(mm)

IEST public account

IEST®

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.iesttech.com E–mail：info@iesttech.com