

Application News

Precision Universal Testing Machines AGS™-V

Peel Test for Cathode Materials of Lithium-Ion Batteries in a Thermostatic Chamber

Tomoya Matsushita

User Benefits

- ◆ A thermostatic chamber makes it possible to measure the adhesion force of cathode materials in actual temperature environments.
- ◆ A copper foil peeling test device enables to conduct peel tests while maintaining a 90° angle in a thermostatic chamber.
- ◆ By using a load cell with a wider accuracy guarantee range than a conventional one, it is possible to conduct high-accuracy tests even with small test forces.

■ Introduction

Lithium-ion batteries play an important role in various electronic devices due to their high energy density and excellent charging efficiency. To improve battery performance, materials and processing methods are actively being developed, and strength measurement is one of the essential evaluation methods.

This Application News focuses on the adhesion strength of the electrode sheets used as battery electrodes. Fig. 1 shows the structure of an electrode sheet. An electrode sheet consists of an electrode material that adheres to a current collector, through which electrons move. The electrode material is composed of a cathode active material such as lithium iron phosphate and an insulating material known as a binder. When the adhesion between the electrode material and the current collector is weak, the electrode material may delaminate from the current collector, preventing electrons from moving in the electrode sheet and increasing the electrical resistance. Therefore, evaluating the adhesion strength is important for improving battery performance.

In this application, test equipment, test conditions, and results of the peel test for battery cathode materials are described. The temperature dependence of the adhesion strength of the electrode materials is also described.

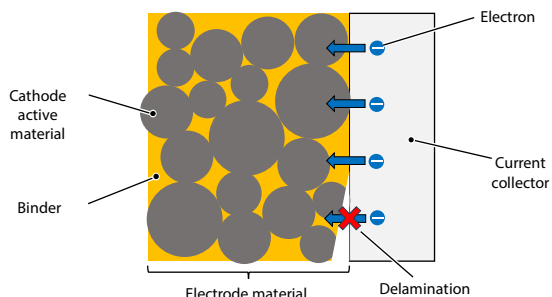


Fig. 1 Structure of an Electrode Sheet

■ Apparatus

Fig. 2 and Table 1 show the test apparatus, and Fig. 3 shows the specimen structure.

The tests were conducted using a Precision Universal Testing Machine AGS™-V, with 1 kN screw-type flat grips and a copper foil peeling test device mounted on it. The specimens consisted of rectangular metal plates covered with double-sided tape, which were then coated with cathode active materials.

The specimens were set in the copper foil peeling test device, and the aluminum foil was gripped by the screw-type flat grip. The foil was always peeled off in a 90° direction relative to the specimen, ensuring that the center of the load coincides with the center of AGS-V.

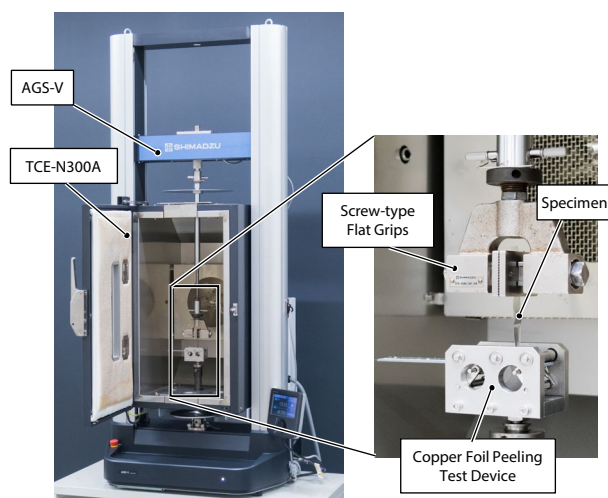


Fig. 2 Test Equipment

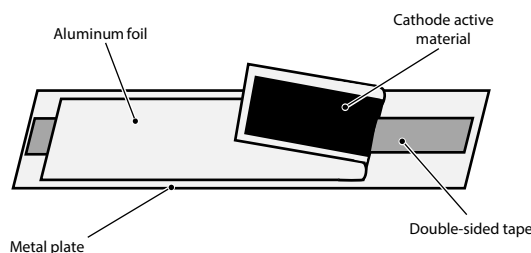


Fig. 3 Specimen Structure

Table 1 Test Apparatus

Testing Machine:	Precision Universal Testing Machine AGS-V
Load Cell Capacity:	500 N
Thermostatic Chamber:	Compact Type Thermostatic Chamber TCE-N300A
Software:	TRAPEZIUM™X-V (Single)
Jigs:	1 kN Screw-type Flat Grip (Upper) Copper Foil Peeling Test Device (Lower)

■ Test Conditions

Table 2 shows test conditions. In this test, the force and its temperature dependence were evaluated. The temperature conditions included room temperature, 50 °C, and 70 °C.

Table 2 Test Conditions

Cathode Active Material:	Lithium Iron Phosphate
Temperature:	Room temp., 50 °C, 70 °C
Test Speed:	5 mm/sec
Disp. Origin:	Force 0.05 N
Target Value:	Stroke 100 mm
Number of Samples:	3

■ Test Results

Fig. 4 shows the force-displacement curve. The dash-dotted curve is at room temperature, dotted curve is at 50 °C, and real curve is at 70 °C. The tests were conducted three times at each temperature whereas the shown curve is one representative specimen of the three.

The average values of adhesion force are shown in Table 3. Adhesion forces were calculated from the average force between 20 mm and 80 mm of the displacement.

These results show that when the temperature gets higher, adhesion force becomes larger.

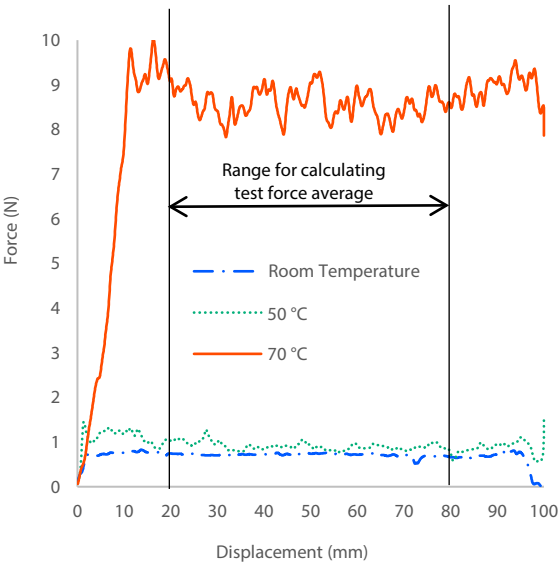


Fig. 4 Test Results

Table 3 Adhesion Strength at each temperature (Average of n = 3)

Temperature	Adhesion Strength (N)
Room Temperature	0.753
50 °C	0.903
70 °C	8.07

■ Conclusion

Peel tests in a thermostatic chamber were conducted using an AGS-V and TCE-N300A for Lithium iron phosphate used as cathode sheet of lithium-ion batteries.

From the test results, it was confirmed that the adhesion force between the cathode active material and the aluminum foil increased as the temperature increased.

This measurement can easily evaluate the temperature dependence of mechanical characteristics of battery cathodes. This method is expected to be applied to solve problems for improving battery performance.

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