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Aluminum and Aluminum Alloy Foils for Lithium-Ion Batteries

锂离子电池用铝及铝合金箔

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Aluminum and Aluminum Alloy Foils for Lithium-Ion Batteries

1 Scope

This Document specifies the classification, technical requirements, test methods, product qualification, process control, inspection rules and marking, packaging, transportation, storage and quality certificates, as well as purchase orders (or contracts) of aluminum and aluminum alloy foils for lithium-ion batteries.

This Document applies to aluminum and aluminum alloy foils (hereinafter referred to as "aluminum foils") for lithium-ion battery current collectors.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 3190 Wrought Aluminum and Aluminum Alloys - Chemical Composition Limits

GB/T 3199 Wrought Aluminum and Aluminum Alloy Products - Packing, Marking, Transporting and Storing

GB/T 7999 Optical Emission Spectrometric Analysis Method of Aluminum And Aluminum Alloys

GB/T 8005.1 Aluminum and Aluminum Alloys - Terms and Definitions - Part 1: Product and Method of Processing and Treatment

GB/T 8170 Rules of Rounding off for Numerical Values & Expression and Judgement of Limiting Values

GB/T 16865 Test Pieces for Tensile Test for Wrought Aluminum and Magnesium Alloy Products

GB/T 17432 Methods of Sampling for Analyzing the Chemical Composition of Wrought Aluminum and Aluminum Alloy

GB/T 20975 (all parts) Methods for Chemical Analysis of Aluminum and Aluminum Alloys

5.8.1.4 The coating of the coating foil shall be uniform, and the coating area shall not be allowed to expose the substrate.

5.8.2 End face

The end face of the aluminum foil is not allowed to have arrows, stains, bumps and other defects, and dense aluminum powder with visible reflected light is not allowed.

6 Test Methods

6.1 Chemical composition

6.1.1 The chemical composition analysis method of the light foil and coating foil substrate shall comply with the provisions of GB/T 20975 or GB/T 7999; and the arbitration analysis shall adopt the method stipulated in GB/T 20975. The "Al" content is calculated according to the method specified in GB/T 3190. When calculating the "Al" content, the sum of the analytical values of the conventional analytical elements and the unconventional analytical elements suspected to be excessive is taken as the "sum of element content".

6.1.2 The determination of the analysis value shall adopt the rounding-off comparison method; the rounding-off rules of the numerical value shall be carried out according to the relevant provisions of GB/T 8170; and the rounding-off digits shall be consistent with the limit digits specified in Table 2 or GB/T 3190.

6.1.3 The chemical composition analysis method for the coating of the coating foil shall be determined through negotiation between the supplier and the purchaser.

6.2 Dimensional deviation

6.2.1 Dimension rounding-off

Dimensional measurements are not allowed to be rounded-off; and the method for determining the limit value shall comply with the provisions of GB/T 8170.

6.2.2 Thickness

The thickness of the light foil and the coating foil substrate shall be determined according to the method specified in GB/T 22638.1. When the purchaser requires the selection of non-standard area samples to measure the thickness, it shall be indicated in the order form (or contract). The measurement method of the thickness extreme difference shall be determined through negotiation between the supplier and the purchaser.

6.2.3 Areal Density

6.2.3.1 The areal density of the light foil and the coating foil substrate shall be determined according to the method specified in GB/T 22638.10. When the purchaser requires the selection

of non-standard area samples to measure the surface density, it shall be indicated in the order form (or contract). The measurement method of areal density extreme difference shall be determined through negotiation between the supplier and the purchaser.

6.2.3.2 The areal density for the coating of the coating foil shall be determined according to the method specified in GB/T 22638.10, or determined through negotiation between the supplier and the purchaser.

6.2.4 Width

Measure with a film ruler or other tool of corresponding accuracy.

6.2.5 Length

Measure with tools of corresponding accuracy.

6.2.6 Burrs, cracked edges

Select the trimming positions on both sides of the aluminum foil roll, and cut the sample including the trimming edge of the aluminum foil along the trimming edge, and the length of the sample shall be greater than 30cm. Under a microscope (optical magnification should be no less than 100×, digital magnification should be no less than 500×), visually check the smoothness of the edge of the sample, crack defects and measure the burr size. It should observe the edge of the aluminum foil from multiple angles.

6.2.7 Plate shape

6.2.7.1 Under the unit tension of 8N/mm^2, visually inspect the aluminum foil for poor plate shape defects.

6.2.7.2 Under the unit tension of 8N/mm^2, the wave height of the aluminum foil wave is measured by the off-line plate shape testing device.

6.2.8 Staggered layer

Measure by tools of corresponding precision.

6.3 Tensile mechanical properties at room temperature

The tensile mechanical properties at room temperature shall be tested according to the method specified in GB/T 16865. The test gauge length is 50mm or 100mm; and the test rate is 5mm/min or 10mm/min, which is determined by the negotiation between the supplier and the purchaser.

6.4 Pinhole

The pinhole offline test is carried out according to the method specified in GB/T 22638.2; and

the pinhole online test method is shown in Appendix A.

6.5 Surface wetting tension

It shall be tested according to the method specified in GB/T 22638.4.

6.6 Joints

Visual inspection.

6.7 Tube core

The dimension deviation of the tube core is measured by a measuring tool that can guarantee the accuracy; the material of the tube core is guaranteed by the supplier; and other items are checked visually.

6.8 Appearance quality

6.8.1 Surface

6.8.1.1 During the arbitration inspection, visually inspect the appearance quality under natural scattered light.

6.8.1.2 The diameter of the circumscribed circle of point defects on the surface of the aluminum foil can be measured by a measuring tool with corresponding accuracy.

6.8.1.3 See Appendix A for the online detection method of holes on the surface of aluminum foil. See Appendix B for on-line detection methods for other surface defects.

6.8.2 End face

Visually inspect the end face quality in a bright environment.

7 Product Qualification

When required by the purchaser, the product qualification of the light foil can be carried out with reference to the provisions of Appendix C.

8 Process Control

The supplier shall control the production process of the product, and the process control shall refer to the provisions of Appendix D.

9.6.8 When the appearance quality of any product is unqualified, the product shall be judged as unqualified.

10 Marking, Packaging, Transportation, Storage and Quality Certificate

10.1 Marking

10.1.1 Product marking

Markings (or labels) shall be made on each roll of products that have passed the inspection, and the contents of the marking are as follows:

a) product name;

b) use code;

c) designation;

d) state;

e) size and specification;

f) batch number or roll number (in order to achieve roll number traceability, barcode format should be used);

g) net weight;

h) The signature (or seal) of the inspection seal or quality inspector of the supplier's technical supervision department.

10.1.2 Marking of packaging box

The marking of packaging box of the product shall comply with the provisions of GB/T 3199. In order to achieve the traceability of the box number, the barcode should be used.

10.2 Packaging, transportation and storage

The packaging, transportation and storage of the product shall comply with the provisions of GB/T 3199.

10.3 Quality certificate

Each batch of aluminum foil shall be accompanied by a product quality certificate, which states:

a) the name of the supplier;

b) product name;

c) use code;

d) grade and status;

e) size and specification;

f) net weight;

g) batch number (or roll number);

h) The inspection results of each analysis item;

i) the document number;

j) the seal of the supplier's technical supervision department;

k) Packaging date (or exit-factory date).

11 Contents of Order Form (or Contract)

An order form (or contract) for the products listed in this Document shall include the following:

a) product name;

b) category (light foil, coating foil or single-sided light foil, double-sided light foil);

c) designation and state;

d) size and specification;

e) weight;

f) tube core material and specifications;

g) Items (thickness/areal density/width/length deviation level, edge burr level, edge crack requirements, wave height level, special requirements for tensile mechanics performance at room temperature, pinhole level, etc.) "that should be indicated in the order form (or contract)" required by this Document;

h) Negotiation results when adding content other than this Document;

i) This Document No.

Appendix B

(Informative)

Online Detection of Surface Defects

B.1 Principle of method

The camera is used to take pictures of the surface of the inspected aluminum foil; and it is compared and analyzed with the surface defect library stored in the system; so as to detect the type, area and distribution of surface defects that affect the use or have the risk of being complained in real time.

B.2 Test conditions

B.2.1 Ambient temperature: 0℃~50℃.

B.2.2 Slitting speed: ≤600m/min.

B.3 Equipment

The surface defect online detector is mainly composed of a host, a camera, and a light source. The camera configuration can cover the entire width of the aluminum foil. The horizontal accuracy is 0.09mm, and the longitudinal accuracy is 0.15mm.

B.4 Specimen

Foil roll.

B.5 Determination

B.5.1 Arrange the testing equipment according to the operating procedures.

B.5.2 Enter the following information in the surface defect online detector, such as roll number, use code, designation, state, width, etc.

B.5.3 After the beginning of the slitting, start the online surface defect detector and start online detection. During the detection process, confirm that the connection between each camera board and the serial port is normal.

B.5.4 After the end of the slitting, turn off the surface defect online detector.

B.6 Representation of result

B.6.1 Evaluate the defect level according to Table B.1.

F – the purchaser confirms the process verification results;

G – the supplier conducts the material qualification (two furnaces and six batches);

H – whether the assessment results is qualified;

I – whether it is because the unqualified production process cause;

J – the purchaser approves the supply qualification of the supplier;

K –formal verification stage of process stability;

L – the supplier's small batches of supply (within 50 batches);

M – the purchaser conducts the assessment on the performance stability and process capability of small batches of products;

N –production and supply in batches stage.

Figure C.1 – Product Qualification Flow Chart

C.2 Product qualification requirements

C.2.1 Process research stage

Before formally launching the full-specification range and full-item supply capability verification of the product, select some thickness specifications, carry out process development, and verify the rationality of the process according to standards or customer requirements. In this way, it is verified whether the supplier has the ability to carry out the production in the full-specification range of products. When the supplier has experience in the production and supply of aluminum and aluminum alloy foils for lithium batteries, the supplier and the purchaser can negotiate and directly enter the next stage.

C.2.2 Formal verification stage of process stability

C.2.2.1 Process stability assessment

C.2.2.1.1 According to the requirements of the purchaser, the supplier shall produce products with no less than 2 smelting furnaces and 6 production batches (hereinafter referred to as two furnaces and six batches) according to the determined process; and the supplier shall submit the test report (customer-certified laboratory or testing capability) until the test results all meet the requirements.

C.2.2.1.2 If any batch is unqualified in continuous production, the previous qualified batches shall be checked. At the same time, the supplier analyzes and finds the reasons for the failure; re-determines the production trial production process; and organizes the production verification and performance assessment of two furnaces and six batches again.

C.2.2.1.3 After the aluminum foil production inspection is completed, the supplier shall form a complete set of process documents, original production records, original test reports, stability analysis reports, summary reports in the development stage, and process rationality explanations and archive them. If required by the purchaser, they shall be provided by the supplier.

C.2.2.2 Material qualification stage

C.2.2.2.1 After the supplier determines the process, it shall carry out the production of 2 smelting furnaces and 2 production batches according to the determined production process; carry out the material qualification identification; and submit it to the laboratory approved by the purchaser for testing until all the test results meet the requirements.

C.2.2.2.2 If any batch is unqualified in continuous production, this stage shall not pass, the supplier shall analyze and find the reason for the disqualification; and report to the purchaser in writing. If it is caused by production process, the supplier shall re-conduct the process research; if it is not caused by production process, the supplier shall reorganize the qualification appraisal.

C.2.2.2.3 On the premise of the corresponding confidentiality clauses, the representatives of the relevant departments of the purchaser have the right to witness and investigate the various processes of the supply capability verification.

C.2.2.2.4 A material qualification report is formed through the material at the material qualification stage; and the report contains the following information: project name, manufacturer's name and address, relevant product production and supply experience, standard number, alloy, state, product dimension, casting batches, heat treatment batches, inspection items and inspection results, original inspection reports, process route descriptions, tooling equipment descriptions, quality certificates, etc.

C.2.3 Production and supply in batches stage

C.2.3.1 After the supplier obtains the supply qualification approved by the purchaser, it shall supply in small batches.

C.2.3.2 After the supply of small batches, the purchaser shall analyze and assess the supply data of small batches. After confirming that the performance and performance stability all meet the requirements of the purchaser, mass production can be carried out.

C.2.3.3 The supplier shall monitor the production process, equipment, etc. according to the requirements of the process control documents during the product batch production process; and regularly conduct relevant tests on the equipment; and conduct stability analysis of the production process parameters to ensure the stability of product performance .

Appendix D

(Informative)

Process Control

D.1 Procedure developed from process control document

After the supplier has the ability to produce qualified products according to the requirements of this Document, it shall carry out the necessary material certification. Before the material certification, the supplier shall prepare a process control document in accordance with the production control requirements specified in this Document. In order to ensure the stability of material quality, and the production or production-related requirements of this product are specified in the process control document. The procedure developed from the process control document is as follows:

a) The supplier produces the specified batches of products that meet the requirements of this Document according to the user's needs;

b) The supplier has a quality system certified by a third party;

c) The supplier formulates process control documents according to the content specified in this Document;

d) Both the supplier and the purchaser confirm the process control document, which shall be implemented after the confirmation takes effect.

D.2 Range and requirements of the process control

D.2.1 Range of process control

In order to ensure the effectiveness of material process control, the process control document includes the following:

a) raw material requirements;

b) process requirements;

c) equipment requirements.

D.2.2 Raw material requirements

D.2.2.1 Raw material process control includes supplier qualification confirmation and raw material quality control.

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