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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 23365-2023

Replacing GB/T 23365-2009

**Electrochemical performance test of lithium cobalt oxide - Test
method for the initial discharge specific capacity and the initial
efficiency**

钴酸锂电化学性能测试 首次放电比容量及首次充放电效率测试方法

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Foreword

This document was drafted in accordance with the rules of GB/T 1.1-2020 Directives for Standardization - Part 1: Rules for the Structure and Drafting of Standardizing Documents. This document serves as a replacement of GB/T 23365-2009 Electrochemical Performance Test of Lithium Cobalt Oxide - Test Method for Specific Capacity and Charge-discharge Efficiency of the First Cycle. In comparison with GB/T 23365-2009, apart from structural adjustments and editorial modifications, the main technical changes are as follows:

- a) The scope of application is modified (see Chapter 1; Chapter 1 of Version 2009);
- b) The requirements for "binder", "lithium ion battery separator", "aluminum foil", "metal lithium sheet" and "electrolyte for lithium ion battery" are modified (see 5.3, 5.4, 5.7, 5.9 and 5.10; 2.5, 2.9, 2.7, 2.1 of Version 2009);
- c) The requirements for "vacuum oven", "dryer", "oven", "electronic balance", "thickness gauge", "roller press", "insulated tweezers", "pipette", "button cell packaging machine" and "thermostatic box" are added (see 6.1, 6.2, 6.7, 6.9 ~ 6.15); the requirements for "inert atmosphere (argon) glove box" are modified (see 6.3; 3.4 of Version 2009);

d) The requirements for "reagent or material pre-treatment" and "data recording" are added (see

e) The requirements for "cathode sheet preparation", "battery assembly" and "battery testing" are modified (see 7.2 ~ 7.4; 4.1 ~

4.3 of Version 2009);

f) The requirement for the precision of calculation results is added "the calculation results shall retain one decimal place" (see

g) "allowable difference" is added (see Chapter 9). Please be noted that certain content of this document may involve patents. The institution issuing this document does not undertake the responsibility of identifying these patents. This document was proposed by China Non-ferrous Metals Industry Association. This document shall be under the jurisdiction of National Technical Committee 243 on Nonferrous Metals of Standardization Administration of China (SAC/TC 243) The drafting organizations of this document: Tianjin Guoan MGL New Materials Co., Ltd.; Beijing Easpring Material Technology Co., Ltd.; Chengdu B&M Science and Technology Co., Ltd.; Hunan Changyuan LICO Co., Ltd.; Guangdong BRUNP Recycling Technology Co., Ltd.; XTC New Energy Materials (Xiamen) Co., Ltd.; Jiangmen Keheng Industry Co., Ltd.; BASF Shanshan Battery Materials Co., Ltd.; Ampere Technology Limited; Tianjin Lishen Battery Joint-Stock Co., Ltd.; Hunan Zhongwei New Energy Technology Co., Ltd.; Gem (Wuxi) Electrochemical Performance Test of Lithium Cobalt Oxide - Test Method for the Initial Discharge Specific Capacity and the Initial Efficiency

1 Scope

China's national method for measuring the initial discharge specific capacity and the initial charge-discharge efficiency of lithium cobalt oxide. It specifies the test method for these two properties of the cathode material. These are the first two numbers a cell maker asks a cathode supplier for, and they mean different things. The specific capacity is how much charge a gram of the material delivers, which sets how much active material a cell of a given capacity needs and therefore its energy density. The initial efficiency is the ratio of the first discharge to the first charge, and the difference between them is charge that went in and did not come out - consumed irreversibly in forming the passivating layer on the electrodes and in structural changes during the first cycle. That loss is paid for at the cell level in a way that is not obvious: the lithium consumed comes from the cathode, so a material with a low first-cycle efficiency requires a larger cathode to deliver the same usable capacity, and the penalty is permanent. Neither number is a property of the powder alone, which is why a test method is needed rather than a specification. Both depend on the electrode formulation and coating weight, the binder and conductive additive, the electrolyte, the counter electrode, the voltage window, the current rate and the temperature - and a supplier quoting a capacity at a low rate over a wide voltage window is quoting a

number a cell will never see. The standard fixes all of it: the half-cell construction, the electrode preparation, the electrolyte and separator, the formation and cycling conditions, the calculation and the precision. Issued on 7 September 2023 and in force since 1 April 2024, it replaces GB/T 23365-2009.

This document describes the test method for the initial discharge specific capacity and initial charge and discharge efficiency of lithium cobalt oxide, which is a lithium ion battery cathode material. This document is applicable to the test of the initial discharge specific capacity and initial charge and discharge efficiency of lithium cobalt oxide, which is a lithium ion battery cathode material. The test of the initial discharge specific capacity and initial charge and discharge efficiency of other lithium ion battery cathode materials may take this document as a reference.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in this text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

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

3 Terms and Definitions

This document does not have terms or definitions that need to be defined.

4 Test Conditions

The test procedures specified in this document, unless otherwise specified, should be carried out in a drying room (the ambient dew point temperature is not greater than 20 C); for the circumstance where there are no conditions for such drying room, the various test procedures shall be carried out under environmental conditions with a relative humidity not greater than 40% and a temperature of 20 C ~ 30 C.

5 Reagents or Materials

5.1 Cathode active material: lithium cobalt oxide.

5.2 Conductive agent: acetylene black or conductive carbon black.

5.3 Binder: polyvinylidene fluoride (PVDF), battery grade, with a relative molecular mass not less than 5 105, and a moisture content (mass fraction) not greater than 0.10%.

5.4 Lithium ion battery separator: polyolefin porous membrane, with a porosity of 35.0% ~ 60.0%, an average pore diameter not greater than 1.0 μ m, a diameter of 16 mm ~ 22 mm, and a thickness of 9.0 μ m ~ 25.0 μ m.

5.5 Standard structural members of button cells: commonly used models CR2016, CR2025, CR2032 or CR2430, including cathode case, anode case, gasket, spring support sheet or foam nickel sheet.

5.6 Absolute ethanol: industrial grade.

5.7 Aluminum foil: battery grade, with a thickness of 10 μ m ~ 20 μ m.

5.8 N-methylpyrrolidone (NMP): battery grade, with a purity not less than 99.9% and a moisture content (mass fraction) not greater than 0.02%.

5.9 Metal lithium sheet: with a diameter of 14 mm ~ 18 mm and a thickness of

0.40 mm ~

0.80 mm.

5.10 Electrolyte for lithium ion battery: made from battery-grade lithium hexafluorophosphate (LiPF₆) dissolved in an organic solvent, with a moisture content (mass fraction) not greater than 0.002%, and free acid (HF) content (mass fraction) not greater than 0.005%.

6 Instruments and Equipment

6.1 Vacuum oven: with a temperature control accuracy of 1.0 $^{\circ}$ C.

6.2 Desiccator: contain appropriate desiccant (such as: color-changing silica gel and phosphorus pentoxide, etc.).

6.3 Inert atmosphere (argon) glove box: with a moisture content (mass fraction) and oxygen content (mass fraction) not greater than 0.0001%.

6.4 Electronic balance: the division value of display is 0.0001 g.

6.5 Dispersing mixer.

6.6 Small coating machine or film applicator.

6.7 Oven: with a temperature control accuracy of 1.0 $^{\circ}$ C.

6.8 Sheet-punching machine.

6.9 Electronic balance: the division value of display is 0.00001 g.

6.10 Thickness gauge: with a resolution of 1 μ m.

6.11 Roller press: for button lithium cells only.