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**Nonferrous Metal Industry Standard of the People's Republic of China**

Doped lithium nickel cobalt manganese oxide

掺杂型镍钴锰酸锂

*(English Translation)*

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**Foreword**

SAC/TC 243 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This document is drafted in accordance with the rules given in the GB/T 1.1—2020 Directive for standardization—Part 1: Rules for structure and drafting of standardization documents.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The issuing body of this document shall not be held responsible for identifying any or all such patent rights.

This document was proposed by China nonferrous metals industry association.

This document was prepared by SAC/TC 243 National Nonferrous Metals Standardization Technical Committee.

Doped lithium nickel cobalt manganese oxide

* 1. Scope

This document specifies designation, technical requirements, test methods, inspection rules, signs, packaging, transportation, storage, accompanying documents and purchase orders of doped lithium nickel cobalt manganese oxide.

This document is applicable to doped lithium nickel cobalt manganese oxide as cathode active material for lithium-ion batteries.

* 1. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the reference document (including any amendments) applies.

GB/T 1717 *Determination of pH value of an aqueous suspension of pigments*

GB/T 5162 *Metallic powders—Determination of tap density*

GB/T 5314 *Powders for powder metallurgical purposes—Sampling*

GB/T 6283 *Chemical products—Determination of water Karl·fischer method (general method)*

GB/T 8170 *Rules of rounding off for numerical values & expression and judgement of limiting values*

GB/T 19077 *Particle size analysis—Laser diffraction methods*

GB/T 19587 *Determination of the specific surface area of solids by gas adsorption using the BET method*

GB/T 20252-2014 *Lithium cobalt oxide*

GB/T 24533-2019 *Graphite negative electrode materials for lithium ion battery*

GB/T 37201 *Electrochemical performance test of lithium nickel cobalt manganese oxide—Test method for discharge specific capacity and charge-discharge columbic efficiency of the first cycle*

GB/T 37207 *Electrochemical performance test of lithium nickel cobalt manganese oxide—Test method for discharge plateau capacity ratio and cycle life*

YS/T 1006.2 *Methods for chemical analysis of lithium nickel cobalt manganese oxide—Part 2: Determination of lithium, nickel, cobalt, manganese, sodium, magnesium, aluminum, potassium, copper, calcium, iron, zinc and silicon content—Inductively coupled plasma atomic emission spectrometry*

YS/T 1339 *Methods for chemical analysis of doped nickel cobalt manganese composite hydroxide—Determination of aluminum, magnesium, titanium, strontium, zirconium, lanthanum and yttrium contents—Inductively coupled plasma atomic emission spectrometry*

JCPDS (09-0063） *Lithium nickelate X-ray powder diffraction standard pattern*

* 1. Terms and definitions

The terms and definitions defined by GB/T 20252-2014 are applicable to this document.

* 1. Designation

The product designation is represented by NCMXYZ (D), in which N represents Nickel (Ni), C represents Cobalt (Co), M represents Manganese (Mn), X represents the mole fraction of Ni, Y represents the mole fraction of Co, Z represents the mole fraction of Mn, And D indicates that the product is doped. If the mole fraction is a single digit, add “0” before the single digit. If the mole fraction of Ni, Co and Mn are all integral multiples of 10, X, Y and Z are the value of the mole fraction divided by ten.

*Example 1:*

*The designation of NCMXYZ(D) with the mole fraction of Ni, Co, Mn of 50:20:30 shall be expressed as NCM523(D).*

*Example 2:*

*The designation of NCMXYZ(D) with the mole fraction of Ni, Co, Mn of 65:15:20 shall be expressed as NCM651520(D).*

*Example 3:*

*The designation of NCMXYZ(D) with the mole fraction of Ni, Co, Mn of 88:9:3 shall be expressed as NCM880903(D).*

* 1. Technical requirements
     1. Chemical compositions

The chemical compositions of product shall conform to the requirements in Table 1.

Table 1 Chemical compositions

|  |  |  |
| --- | --- | --- |
| Elements | | Chemical compositions (mass fraction)  % |
| Main elements | Ni+Co+Mna | 55.00～60.00 |
| Li | 6.50～7.80 |
| Doping elements | Zr、Al、Mg、Si、Ti、B、Fb | ≤2.00c |
| Impurity elementsd | Na | ≤0.0300 |
| Ca | ≤0.0200 |
| Fe | ≤0.0050 |
| Zn | ≤0.0050 |
| Cu | ≤0.0050 |
| Cr | ≤0.0050 |
| S | ≤0.1700 |
| a The mole fraction of nickel, cobalt, and manganese in product may be determined by the suppliers and buyers. The allowable variation of the mole fraction shall not be more than ±1.00%。  b The doped elements can be elements other than Zr, Al, Mg, Si, Ti, B and F, and the specific requirements may be determined by the suppliers and buyers.  c The doped elements may be a certain element or several of them. The total content of doped elements shall not be more than 2.00%.  d If the doped elements are the impurity elements listed above, the impurity content of the elements shall not be specified. | | |

* + 1. Moisture content

The moisture content of product shall not be more than 0,05%.

* + 1. Magnetic impurity content

The magnetic impurity content of product shall not be more than 0,000 005%.

* + 1. Residual alkali content

The residual alkali content of product expressed as free lithium content shall not be more than 0,26%.

* + 1. pH value

The pH value of product shall be in the range of 10,0~12,5.

* + 1. Appearance quality

The appearance of product shall be powder in uniform black color. Agglomeration and impurities are not acceptable.

* + 1. Crystal structure

The crystal structure of product shall conform to JCPDS (09-0063).

* + 1. Tap density

The tap density of product shall not be less than 1,8 g/cm3.

* + 1. Particle size distribution

The particle size distribution of product shall be in normal distribution. Characteristics value of the particle size distribution shall conform to the requirements given in Table 2.

Table 2 The particle size distribution

|  |  |
| --- | --- |
| The characteristic value of the particle size distribution | Particle size /μm |
| *D*10 | ≥1,0 |
| *D*50 | 3,0～20,0 |
| *D*90 | ≤30,0 |

* + 1. Specific surface area

The specific surface area of product shall not be more than 1,5 m2/g.

* + 1. Initial specific discharge capacity

The initial specific discharge capacity of products with typical designation shall conform to the requirements given in Table 3.

Table 3 The initial discharge specific capacity of typical designation product

|  |  |
| --- | --- |
| Typical designation | The initial specific discharge capacity  mA **.** h/g |
| NCM523（D） | ≥165 |
| NCM622（D） | ≥175 |
| NCM712（D） | ≥190 |
| NCM811（D） | ≥200 |
| NCM551530（D） | ≥170 |
| NCM651520（D） | ≥180 |

* + 1. Initial charge-discharge efficiency

The initial charge-discharge efficiency of product under the specified condition is less than 85%.

* + 1. Cycle life

In the specified conditions, the number of cycles shall not be less than 1000, when the discharge capacity of product drops to 80% of the initial discharge capacity.

* + 1. Others

Any special requirements, from the buyer of the NCMXYZ (D), may be determined by the supplier and buyer through negotiation.

* 1. Test methods
     1. Chemical compositions

The content of Ni, Co, Mn, Li, Na, Ca, Fe, Zn and Cu in product shall be determined as specified in YS/T 1006.2.

The content of the doping elements in product shall be determined as specified in YS/T 1339 or in accordance with the method negotiated by the supplier and buyer.

The content of Cr and S in product shall be determined in accordance with the method negotiated by the supplier and buyer.

* + 1. Moisture content

The moisture content of product shall be determined as specified in GB/T 6283.

* + 1. Magnetic impurity content

The content of the magnetic impurity of product shall be determined as specified in GB/T 24533—2019, Annex K.

* + 1. Residual alkali content

The residual alkali content of product shall be determined in accordance with the method negotiated by the supplier and buyer.

* + 1. pH value

The pH value of product shall be determined as specified in GB/T 1717.

* + 1. Appearance quality

The appearance quality of product shall be inspected visually.

* + 1. Crystal structure

The crystal structure of product shall be detected by X-ray powder diffractometer.

* + 1. Tap density

The tap density of product shall be determined as specified in GB/T 5162.

* + 1. Particle size distribution

The particle size distribution of product shall be determined as specified in GB/T 19077.

* + 1. Specific surface area

The specific surface area of product shall be determined as specified in GB/T 19587.

* + 1. Initial specific discharge capacity

The Initial specific discharge capacity of product shall be determined as specified in GB/T 37201. The charge/discharge voltage range shall be 2,80 V ~ 4,30 V with other conditions fixed. It may also be carried out in accordance with the method negotiated by the supplier and buyer.

* + 1. Initial charge/discharge efficiency

The initial charge/discharge efficiency of product shall be determined as specified in GB/T 37201. The charge/discharge voltage range shall be 2,80 V ~ 4,30 V with other conditions fixed. It may also be carried out in accordance with the method negotiated by the supplier and buyer.

* + 1. Cycle life

The cycle life of product shall be determined as specified in GB/T 37207. The charge/discharge voltage range shall be 2,80 V ~ 4,30 V with other conditions unchanged. It may also be carried out in accordance with the method negotiated by the supplier and buyer.

* 1. Inspection provisions
     1. Inspection and acceptance

The product shall be inspected by the supplier or third party to guarantee that the product quality conforms to the provisions of this document and the purchase order.

The buyer may inspect the received product according to the provisions of this document and the purchase order. If the inspection results do not conform to the provisions of this document and the purchase order, the buyer shall notify to the supplier within 3 months from the date of reception, which the disagreement shall be settled by the supplier and buyer through negotiations. In case of any arbitration, samples shall be obtained from buyer and inspection shall be carried out by both the supplier and the buyer.

* + 1. Lot

The product shall be submitted in lots for inspection, and each lot shall consist of the same designation, production cycle and chemical composition. The weight of each lot shall not exceed 5 t. If the buyer has special requirements, the requirements shall be determined by the supplier and buyer through negotiation.

* + 1. Inspection items and sampling
       1. Inspection classification

The product inspection specified in this document is divided into:

a） Lot by lot inspection;

b） Periodic inspection.

* + - 1. Lot by lot inspection

Each lot of products shall be inspected.

* + - 1. Periodic inspection

Conduct a periodic inspection once a month during normal production. In case of major changes in raw materials or production processes or resumption of production after long-term shutdown, periodic inspection shall be carried out.

* + - 1. Inspection items and sampling quantity of each lot of product

The items and sampling quantity of lot by lot inspection and periodic inspection are shown in Table 4.

Table 4 Inspection items and sampling quantity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Inspection items | Sampling quantity | Section number for technical requirements | Section number for testing methods | Inspection category |
| Chemical compositions | One per lot | 5.1 | 6.1 | lot by lot inspection |
| Moisture content | One per lot | 5.2 | 6.2 | lot by lot inspection |
| Magnetic impurity content | One per lot | 5.3 | 6.3 | lot by lot inspection |
| Residual alkali content | One per lot | 5.4 | 6.4 | lot by lot inspection |
| pH | One per lot | 5.5 | 6.5 | lot by lot inspection |
| Appearance quality | Barrel by barrel  Or  Bag by bag | 5.6 | 6.6 | lot by lot inspection |
| Crystal structure | One per lot | 5.7 | 6.7 | periodic inspection |
| Tap density | One per lot | 5.8 | 6.8 | lot by lot inspection |
| Particle size distribution | One per lot | 5.9 | 6.9 | lot by lot inspection |
| Specific surface area | One per lot | 5.10 | 6.10 | lot by lot inspection |
| Initial discharge specific capacity | One per lot | 5.11 | 6.11 | periodic inspection |
| Initial charge-discharge efficiency | One per lot | 5.12 | 6.12 | periodic inspection |
| Cycle life | One per lot | 5.13 | 6.13 | periodic inspection |

The sampling method of product shall be conducted as specified in GB/T 5314. The total amount of each lot of samples shall not be less than 5 kg.

* + 1. Inspection results judgement

The inspection result shall be rounded as specified in GB/T 8170 and judged by the rounding value comparison method.

The lot of products shall be judged as unqualified if any of the requirements is unqualified--chemical composition, moisture content, magnetic impurity content, residual alkali content, pH, crystal structure, tap density, particle size distribution and specific surface area.

The barrel (bag) of products shall be judged as unqualified if the appearance quality inspection is unqualified.

Prepare six test batteries according to the method specified in GB/T 37201. Select any three of them for the inspection of the initial specific discharge capacity and the initial charge-discharge efficiency. If the performance of two of the three batteries fails to meet the performance requirements specified in this document, another three batteries can be selected for the repeated test. If the performance of two of the three batteries in the second round still fails to meet the performance requirements specified in this document, judge this lot of product to be unqualified.

Prepare six test batteries according to the method specified in GB/T 37201. Select any three of them for the inspection of the cycle life. If the performance of two of the three batteries fails to meet the performance requirements specified in this document, another three batteries can be selected for the repeated test. If the performance of two of the three batteries in the second round still fails to meet the performance requirements specified in this document, judge this lot of product to be unqualified.

* 1. Signs, packaging, transportation, storage and accompanying documents
     1. Signs

The outer packaging of products shall be accompanied by the following contents.

a） Product name;

b） Lot number;

c） Net weight;

d） The supplier name;

e） Factory address;

f） "Rainproof" sign.

* + 1. Packaging

Products should be packed in aluminum-plastic bags, sealed, and put into the barrel in net weight of 25 kg.

Products should be packed in woven bags lined with aluminum-plastic bags in net weight of 500 kg and sealed. .

If the buyer has special requirements for packaging, the packing form shall be determined by the supplier and buyer through negotiation.

* + 1. Transportation and storage

Avoid damage to the package during transportation of products.

Avoid moisture and corrosion during storage of products. The shelf life of the product is one year from the date of production.

* + 1. Accompanying Documents

Each lot of products shall have accompanying documents, which shall include supplier information, product information, document number, production date or packaging date, and should also include:

a） product quality guarantee:

* Main performance and technical parameters of product;
* Product characteristics (including manufacturing process and raw material characteristics);
* Obligations on product quality;
* The quality certification report of the product and the analysis inspection results, which are certified by the technical supervision department of the supplier.

b） quality certification:

* Inspection items and results or inspection conclusion;
* Lot size or lot number;
* Production date;
* Inspection date;
* Signature or stamp seal by inspector.

c） inspection report in the process of product quality control and finished product inspection report;

d） product instructions: correct handling, use and storage methods, etc.;

e） others.

* 1. Purchase order contents

The buyers may, according to their own needs, list the following contents in the purchase order:

a） product name;

b） designation;

c） chemical compositions (with special requirements);

d） net weight and amount;

e） the reference number of this document;

f） others.

