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

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Hard carbon

硬炭

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1 Scope

China's national standard for hard carbon. Hard carbon is a non-graphitising carbon: heated to high temperature it does not develop the ordered layer structure of graphite but retains a disordered arrangement of curved and randomly stacked graphene fragments with nanoscale voids between them. That disorder is the point. It is the leading anode material for sodium-ion batteries, because sodium ions are too large to intercalate into graphite the way lithium does, while hard carbon's disordered structure and pores accommodate them readily. Sodium-ion batteries matter to China for reasons of supply: sodium is unlimited and cheap, and the technology avoids lithium and cobalt entirely, which makes it attractive for grid storage and for low-cost vehicles. Hard carbon is made from precursors including biomass, and the standard has to specify the properties that predict electrochemical behaviour rather than only the composition.

This document specifies the classification and code, technical requirements, test methods, inspection rules, packaging, marks, storage and transportation of hard carbon materials. This document applies to hard carbon materials for lithium-ion batteries, lithium-ion capacitors and sodium-ion batteries.

2 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 referenced document (including any amendments) applies.

GB/T 1427, Specimen method of carbon material GB/T 4369-2015, Lithium

GB/T 6682, Water for analytical laboratory use -- Specification and test methods

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

GB/T 8719, General rule for packing, marking, storage, transport and quality certificates of carbonaceous material and products

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 21354, Powders -- Determination of tap density

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 hard carbon Amorphous carbon that is difficult to graphitize at temperatures above 2500°C NOTE. It is generally believed that amorphous carbon with a (002) interplanar spacing (d_{002}) greater than or equal to

0.368 nm is hard carbon.

4 Classification and code

4.1 Product classification Hard carbon products are classified into resin hard carbon, asphalt hard carbon and bio- based hard carbon according to the raw material.

a) Resin hard carbon. hard carbon made from natural or synthetic resin polymer materials, represented by RHC.

b) Asphalt hard carbon. hard carbon made from coal tar or petroleum asphalt, represented by PHC.

c) Bio-based hard carbon. hard carbon made from animals and plants, represented by BHC.

4.2 Product grades Product grades are classified according to Table 1.

4.3 Product code The product code is composed of the classification code, first discharge specific capacity, and median particle size (D_{50}) in sequence. See Table 2 for specific examples.

5 Technical requirements

5.1 Appearance Black powder material, no metallic luster, no impurities visible.

5.2 Physical and chemical indicators The physical and chemical indicators of hard carbon materials shall comply with the requirements of Table 3, Table 4 and Table

5.If there are special requirements, they shall be determined through negotiation between the supplier and the buyer.

6 Test methods

6.1 Appearance Visual observation under sufficient lighting conditions.

6.2 Particle size distribution Measure in accordance with the provisions of GB/T 19077.

6.3 Moisture content The moisture content shall be determined in accordance with the provisions of Annex B of GB/T 24533-2019.

6.4 pH value The pH value shall be determined in accordance with the provisions of Annex C of GB/T 24533-2019.

6.5 Specific surface area Measure in accordance with the provisions of GB/T 19587. 6.6 (002) Interplanar spacing (d002) Measure in accordance with the provisions of Annex E of GB/T 24533-2019.

6.7 First discharge specific capacity and first coulombic efficiency Measure in accordance with the provisions of Annex A.

6.8 Trace metal elements Measure in accordance with the provisions of Annex H of GB/T 24533-2019.

6.9 Magnetic materials Measure in accordance with the provisions of Annex K of GB/T 24533-2019.

6.10 Tap density Measure in accordance with the provisions of GB/T 21354.

7 Inspection rules

7.1 Sampling method Sampling shall be carried out in accordance with GB/T 1427. Samples shall be kept in a sealed container.

7.2 Inspection categories

7.2.1 Exit-factory inspection Exit-factory inspection items. particle size, moisture, pH value, tap density, specific surface area, inter-planer spacing, first discharge specific capacity, first coulomb efficiency, trace elements and magnetic substances.

7.2.2 Type inspection Type inspection items include all technical requirements specified in Chapter

5.Type inspection shall be carried out in any of the following situations.

- a) When there are changes in the model or supplier of raw materials;
- b) When there are changes in the production process;
- c) When the production equipment has been shut down for more than half a year and is resuming production.

7.3 Acceptance rules

7.3.1 Products that meet all technical indicators in Table 3, Table 4 or Table 5 are qualified products. If any indicator does not meet the requirements, double sampling shall be taken from the sampling bag of the same batch of products to re-test the unqualified items. If all the re-test results meet the requirements, the batch of products is judged to be qualified products, otherwise, the batch of products is judged to be unqualified products.

7.3.2 Products shipped by the manufacturer shall comply with the requirements of this document. Each batch of products shall be accompanied by an inspection report when shipped.

7.3.3 The re-inspection period is 1 month. If there is any objection, double sampling shall be carried out for re-inspection. If there is still a dispute, the inspection shall be carried out by a qualified third-party testing agency.

8 Packaging, marks, storage and transportation

8.1 The packaging and labeling of the product shall comply with the provisions of GB/T 8719.The net weight shall be negotiated by the supplier and the buyer.

8.2 Packaging shall be carried out in a dry environment. Put the product into waterproof packaging bags (polyethylene sealed bags and aluminum-plastic sealed bags are recommended). Special packaging requirements shall be agreed upon by the supplier and the buyer.

8.3 Products shall be stored in a ventilated and dry warehouse.

8.4 Products shall be stacked neatly and cleanly. Labels such as production batch numbers shall be clearly identifiable.

8.5 Avoid mixing storage or transportation with items that may cause product deterioration or damage packaging bags.

8.6 The product packaging shall not be damaged during storage and transportation.