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

GB/T 13560-2017

Replacing GB/T 13560-2009

Sintered neodymium iron boron permanent magnets

烧结钕铁硼永磁材料

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1 Scope

China's national standard for sintered neodymium iron boron permanent magnets - the strongest permanent magnets made, and the material behind almost every high performance electric motor, generator, actuator, loudspeaker and hard disc drive of the last four decades. China produces the great majority of them, so this is the specification much of the world's supply is sold against. It specifies the requirements, the test methods, the inspection rules, and the marking, packaging, transport, storage and quality certificate for sintered neodymium iron boron permanent magnet materials. The properties that define a permanent magnet are three, and the grades in this standard are built from them: the remanence, which is the flux density the magnet retains and which sets how much work it can do; the coercivity, which is how strongly it resists being demagnetised; and the maximum energy product, which is the figure of merit combining the two. The reason the grade designations pair a remanence class with a coercivity class is that the two trade against each other, and which matters more depends entirely on the application - a loudspeaker wants remanence, a traction motor that will run hot wants coercivity. That temperature dependence is the material's characteristic weakness and the requirement a purchaser must read most carefully: neodymium magnets lose flux as they warm and demagnetise irreversibly above a temperature that depends on the grade and on the working point, so the standard specifies the temperature coefficients and the maximum working temperature alongside the magnetic properties. To those are added the density, the mechanical properties of a material that is hard and brittle and cannot be machined conventionally, and the corrosion resistance and surface treatment - because sintered

NdFeB corrodes readily and is always coated. Issued on 14 October 2017 and in force since 1 May 2018, it replaces GB/T 13560-2009.

This standard specifies the requirements, test methods, inspection rules and markings, packaging, transportation, storage and quality certificates of sintered neodymium iron boron permanent magnets. This standard applies to sintered neodymium iron boron permanent magnets produced by powder metallurgy.

2 Normative references

The following documents are essential to the application of 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) are applicable to this standard.

GB/T 2828.1-2012 Sampling procedures for inspection by attributes - Part 1. Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

GB/T 3217 Permanent magnet (magnetically hard) materials - Methods of measurement of magnetic properties

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

GB/T 9637 Electrotechnical terminology - Magnetic materials and components

GB/T 15676 Terms for rare earths

GB/T 24270 Method of measurement of temperature coefficient of magnetic properties of permanent magnetic materials

GB/T 29628 Guides for methods of measurement of the magnetic properties of permanent (magnetically hard) materials by pulsed field magnetometry

GB/T 34491 Coatings for sintered neodymium iron boron permanent magnets

3 Terms and definitions

The terms and definitions as defined in GB/T 9637 and GB/T 15676 as well as the following terms and definitions apply to this document.

3.1 Principal magnetic properties It mainly includes residual magnetization of permanent magnets B_r , magnetic polarization coercivity (inner coercivity) H_{cJ} , magnetic induction coercivity H_{cB} , maximum magnetic energy product $(BH)_{max}$.

3.2 Additional magnetic properties It mainly includes the relative recoil permeability μ_{rec} of the permanent magnet, the remanence temperature coefficient $\alpha(B_r)$, the magnetic polarization coercivity (inner coercivity) temperature coefficient $\alpha(H_{cJ})$, the Curie

temperature T_c .

3.3 Irreversible flux losses In an open circuit state, the irreversible amount of relative change in the magnetic flux of the permanent magnet as a function of temperature increases. The calculation method of irreversible flux loss is as shown in formula (1).

3.4 Maximum operating temperature A permanent magnet cylinder sample with a thermal demagnetization state of $L/D = 0.7$ (diameter D , height L), after saturation magnetization, is heated from room temperature to a constant temperature for 2 h in an open circuit state, then cooled to room temperature, its open circuit irreversible flux loss $\leq 5\%$ of the maximum holding temperature.

4 Material classification and grades

4.1 Material classification Sintered neodymium iron boron permanent magnet is divided into low coercivity N, medium coercivity M, high coercivity H, super-high coercivity SH, ultra-high coercivity UH, extremely high coercivity EH, top high coercivity TH in accordance with the intrinsic coercivity.

4.2 Material grade Each type of product is divided into several grades in accordance with the maximum magnetic energy product. Each grade of material can be processed into permanent magnet parts of various shapes and specifications such as discs, cylinders, rings and tiles.

4.3 Character grade representation method The grade of sintered neodymium iron boron permanent magnets is composed of material manufacturing characteristics, main name and magnetic characteristics. The first part S indicates the manufacturing characteristics of the material, which uses the Chinese phonetic alphabet S to indicate the sintered material produced by the powder metallurgy sintering process; the second part is the main name, which is composed of the element symbol Nd of neodymium, the element symbol Fe of iron and the element symbol B of boron, that is, NdFeB;

5 Requirements

5.1 The principal magnetic properties and squareness of the material at room temperature 20 °C shall comply with the requirements of Table

1. Table 1 does not include the parameters of other grades produced by the dysprosium diffusion new process. If there are special requirements by the purchaser, the supplier and the purchaser may negotiate separately.

5.2 The material of each grade can be divided into blank state and machining state. The dimensional deviation, shape and position deviation of the material (referred to as the shape and position deviation) can be found in Appendix A. Special requirements can be determined by both parties through negotiation.

5.3 The additional magnetic properties and main mechanical and physical properties of the materials are listed in Appendix B. They are for reference only for user design and use, they are not used as the basis for acceptance and rejection.

5.6 For the chemical composition, manufacturing process and application of the product, see Appendix C.

5.7 For the magnetic properties unit system, conversion table and grade Type Character grade Principal magnetic properties Squareness minimum value minimum value minimum value minimum value range value

6 Test methods

6.1 The principal magnetic property test methods for type N, M, H, SH and UH materials shall be carried out in accordance with the provisions of GB/T 3217. The principal magnetic property test methods for EH and TH materials shall be carried out in accordance with the provisions of GB/T 29628.

6.2 The test method of the remanence temperature coefficient and the intrinsic coercivity temperature coefficient of the material shall be carried out in accordance with the provisions of GB/T 24270.

6.3 Product size and shape & position deviation shall be tested by gages that meet the accuracy requirements and meet the national measurement standards, or otherwise tested by special gauges confirmed by both parties through negotiation.

6.4 Appearance quality of the product shall be visually inspected.

6.5 Coating test method shall be carried out in accordance with the provisions of GB/T 34491.

6.6 The numerical rounding off shall be carried out in accordance with the provisions of GB/T 8170.

7.1 Inspection and acceptance

7.1.1 The product shall be inspected by the supplier's quality inspection department, to ensure that the materials meet the requirements of this standard, meanwhile the quality certificate shall be filled.

7.1.2 The acquirer shall inspect the products received in accordance with the provisions of this standard. If the inspection result is inconsistent with the provisions of this standard, it shall be submitted to the supplier within one month from the date of receipt of the product, to be settled through negotiation between the supplier and the purchaser. If arbitration is required, it shall be jointly sampled at the purchaser's premise and tested by the organization which is jointly recognized by both parties.