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Rare earth ferrosilicon magnesium alloy

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（*English Translation*）

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Standardization Administration of the People's Republic of China

Foreword

SAC/TC 229 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 *Directives for standardization—Part 1: Rules for the structure and drafting of standardizing documents.*

This document replaces the GB/T 4138—2015 (*Rare earth ferrosilicon magnesium alloy*) in whole. In addition to some structural adjustment and editorial changes, the following technical deviations have been made with respect to the GB/T 4138—2015:

a）Revised the scope of application (see Chapter 1, see Chapter 1 of the 2015 edition);

b) Added classification (see chapter 4);

c) Revised the chemical composition requirements (see 5.1, see 5.1 of the 2015 edition);

d) Added the requirement for product particle size range (see 5.2);

e) Added the condition requirement of "under naturally scattered light" (see 6.3);

f) Added product quality inspectors (see 7.1.1);

g) Revised the rules for "sampling" (see 7.4, see 5.4 of the 2015 edition);

h) Revised the packaging requirements (see 8.1, see 6.2 of the 2015 edition);

i) Revised the marking, transportation and storage (see 8.2,see 6.1, 6.3, 6.4 of the 2015 edition);

j) Added "accompanying documents" (see 8.3);

Attention is drawn to the possibility that some of the elements of this standard 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 standard was proposed and prepared by SAC/TC 229 (the National Standardization Technical Committee of Rare Earth).

The previous editions of this document are as follows:

——The first edition was issued in 1984 as GB/T 4138—1984;

——The first revision was issued in 1993. The second revision was issued in 2004. The third revision was issued in 2015.

——This is the fourth revised edition.

Rare earth ferrosilicon magnesium alloy

1 Scope

This standard specifies the classification, technical requirements, test methods, inspection rules, packing, marking, transportation, storage and accompanying documents for the rare earth ferrosilicon magnesium alloy products.

This standard is applicable to light rare earth ferrosilicon magnesium alloy and yttrium-based heavy rare earth magnesium ferrosilicon alloy produced by mix-melting method. The rare earth magnesium ferrosilicon alloy should be used as nodulizer and vermiculizer.

2 Normative references

The following normative documents through reference in this text, constitute provisions of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

GB/T 13247 *Methods for sampling and testing the grain size of ferroalloys products*

GB/T 15676 *Rare earth-Terms and definitions*

GB/T 16477(All Parts) *Chemical analysis methods of rare earth ferrosilicon alloy and rare earth ferrosilicon magnesium alloy*

GB/T 24194 *Ferrosilicon-Determination of aluminium, calcium, manganese, chromium, titanium, copper, phosphorus and nickel content-Inductively coupled plasma atomic emission spectrometric method*

GB 39176 *Rare earth products packing, marking, transport and storage*

3 Terms and definitions

Defined in GB/T 15676 and the following terms and definitions apply to this document.

3.1 Light rare earth magnesium ferrosilicon alloy

A kind of alloy which mainly contains lanthanum mischmetal or cerium mischmetal, magnesium, silicon and iron.

3.2 Yttrium-based heavy rare earth magnesium ferrosilicon alloy

A kind of alloy which mainly contains yttrium mischmetal, magnesium, silicon and iron.

3.3 Mix-melting method

A method in which raw materials and flux are heated by fuel or electric energy to molten at certain temperature to prepare alloy.

4 classification

4.1 Designation

Rare earth ferrosilicon magnesium alloy can be divided into light rare earth ferrosilicon magnesium alloy and yttrium-based heavy rare earth magnesium ferrosilicon alloy. The light rare earth ferrosilicon magnesium alloy products are divided into 15 grades according to chemical composition, the heavy rare earth ferrosilicon magnesium alloy products are divided into 14 grades according to chemical composition.

4.2 Designation system for rare earth

The designation of rare earth ferrosilicon magnesium alloy comprises three levels. The first level represents rare earth ferrosilicon magnesium alloy, expressed by the chemical symbol of rare earth ferrosilicon magnesium alloy as“REMgSiFe”. The second level represents the mass fraction of the total amount of rare earth in the product, expressed by numbers as “××”. The third level represents the category and content of rare earth elements, magnesium or calcium, the category of the rare earth elements is expressed by “La”, “Ce” and “Y”.The different content of magnesium or calcium, expressed by “A”, “B”, “C” and “D”. The designation is expressed in following format:

REMgSiFe-××-La(Ce/Y)A(B/C/D)

La(Ce/Y): rare earth element La(Ce/Y),

A(B/C/D): the content of magnesium or calcium

the mass fraction of the total amount of rare earth，××is the number

rare earth ferrosilicon magnesium alloy

Example:

REMgSiFe-01-CeA represents a rare earth ferrosilicon magnesium alloy product with about 1% rare earth, and the main type of rare earth element is Ce.

5 Technical requirements

5.1 Chemical composition

The chemical composition of light rare earth ferrosilicon magnesium alloy shall be as specified in Table 1. The chemical composition of yttrium-based heavy rare earth magnesium ferrosilicon alloy shall be as specified in Table 2.

By agreement between the supplier and purchaser, the product with other special requirements can also be adopted.

Table 1 Light rare earth ferrosilicon magnesium alloy

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Designation | Chemical composition (mass fraction)  % | | | | | | | | | | |
| REa | La/RE | Ce/RE | Mgb | Ca | Si | Mn | Ti | MgOc | Al | Fe |
| REMgSiFe-01-LaA | 0.5≤RE＜2.0 | ≥60 | / | 5.5≤Mg＜6.5 | 1.0≤Ca＜3.0 | ≤46.0 | ≤1.0 | ≤1.0 | ≤0.55 | ≤1.0 | Allowance |
| REMgSiFe-01-LaB | 0.5≤RE＜2.0 | ≥60 | / | 6.5≤Mg＜7.5 | 1.0≤Ca＜3.0 | ≤46.0 | ≤1.0 | ≤1.0 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-01-CeA | 0.5≤RE＜2.0 | / | ≥60 | 4.5≤Mg＜5.5 | 1.5≤Ca＜3.0 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.55 | ≤1.0 | Allowance |
| REMgSiFe-01-CeB | 0.5≤RE＜2.0 | / | ≥60 | 5.5≤Mg＜6.5 | 1.5≤Ca＜3.0 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-01-CeC | 0.5≤RE＜2.0 | / | ≥60 | 6.5≤Mg＜7.5 | 1.0≤Ca＜2.5 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.75 | ≤1.0 | Allowance |
| REMgSiFe-01-CeD | 0.5≤RE＜2.0 | / | ≥60 | 7.5≤Mg＜8.5 | 1.0≤Ca＜2.5 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.85 | ≤1.0 | Allowance |
| REMgSiFe-03-CeA | 2.0≤RE＜4.0 | / | ≥60 | 6.0≤Mg＜8.0 | 1.0≤Ca＜2.0 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.8 | ≤1.0 | Allowance |
| REMgSiFe-03-CeB | 2.0≤RE＜4.0 | / | ≥60 | 6.0≤Mg＜8.0 | 2.0≤Ca＜3.5 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.8 | ≤1.0 | Allowance |
| REMgSiFe-03-CeC | 2.0≤RE＜4.0 | / | ≥60 | 7.0≤Mg＜9.0 | 1.0≤Ca＜2.0 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-03-CeD | 2.0≤RE＜4.0 | / | ≥60 | 7.0≤Mg＜9.0 | 2.0≤Ca＜3.5 | ≤45.0 | ≤1.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-05-CeA | 4.0≤RE＜6.0 | / | ≥60 | 7.0≤Mg＜9.0 | 1.0≤Ca＜2.0 | ≤44.0 | ≤2.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-05-CeB | 4.0≤RE＜6.0 | / | ≥60 | 7.0≤Mg＜9.0 | 2.0≤Ca＜3.0 | ≤44.0 | ≤2.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-07-CeA | 6.0≤RE＜8.0 | / | ≥60 | 7.0≤Mg＜9.0 | 1.0≤Ca＜2.0 | ≤44.0 | ≤2.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-07-CeB | 6.0≤RE＜8.0 | / | ≥60 | 7.0≤Mg＜9.0 | 2.0≤Ca＜3.0 | ≤44.0 | ≤2.0 | ≤1.0 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-07-CeC | 6.0≤RE＜8.0 | / | ≥60 | 9.0≤Mg＜11.0 | 1.0≤Ca＜3.0 | ≤44.0 | ≤2.0 | ≤1.0 | ≤1.1 | ≤1.0 | Allowance |
| For high toughness and heavy section ductile iron casting products, Ba, Bi, Sb may be added appropriately;  a：mainly including La, Ce;  b：the content of total magnesium;  c：the content of magnesium oxide. | | | | | | | | | | | |

Table 2 Yttrium-based heavy rare earth magnesium ferrosilicon alloy

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Designation | Chemical composition (mass fraction)  % | | | | | | | | | |
| REa | Y/RE | Mga | Ca | Si | Mn | Ti | MgOb | Al | Fe |
| REMgSiFe-01-YA | 0.5≤RE＜1.5 | ≥50 | 4.5≤Mg＜5.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.55 | ≤1.0 | Allowance |
| REMgSiFe-01-YB | 0.5≤RE＜1.5 | ≥50 | 5.5≤Mg＜6.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-01-YC | 0.5≤RE＜1.5 | ≥50 | 6.5≤Mg＜7.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.75 | ≤1.0 | Allowance |
| REMgSiFe-02-YA | 1.5≤RE＜2.5 | ≥50 | 4.5≤Mg＜5.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.55 | ≤1.0 | Allowance |
| REMgSiFe-02-YB | 1.5≤RE＜2.5 | ≥50 | 5.5≤Mg＜6.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-02-YC | 1.5≤RE＜2.5 | ≥50 | 6.5≤Mg＜7.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.75 | ≤1.0 | Allowance |
| REMgSiFe-03-YA | 2.5≤RE＜3.5 | ≥50 | 5.5≤Mg＜6.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-03-YB | 2.5≤RE＜3.5 | ≥50 | 6.5≤Mg＜7.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.75 | ≤1.0 | Allowance |
| REMgSiFe-03-YC | 2.5≤RE＜3.5 | ≥50 | 7.5≤Mg＜8.5 | 1.0≤Ca＜2.5 | ≤48 | ≤1.0 | ≤0.5 | ≤0.85 | ≤1.0 | Allowance |
| REMgSiFe-04-YA | 3.5≤RE＜4.5 | ≥50 | 5.5≤Mg＜6.5 | 1.0≤Ca＜2.5 | ≤46 | ≤1.0 | ≤0.5 | ≤0.65 | ≤1.0 | Allowance |
| REMgSiFe-05-YA | 4.5≤RE＜5.5 | ≥50 | 6.0≤Mg＜8.0 | 1.0≤Ca＜3.0 | ≤46 | ≤1.0 | ≤0.5 | ≤0.8 | ≤1.0 | Allowance |
| REMgSiFe-06-YA | 5.5≤RE＜6.5 | ≥50 | 6.0≤Mg＜8.0 | 1.0≤Ca＜3.0 | ≤46 | ≤1.0 | ≤0.5 | ≤0.8 | ≤1.0 | Allowance |
| REMgSiFe-07-YA | 6.5≤RE＜7.5 | ≥50 | 7.0≤Mg＜9.0 | 1.0≤Ca＜3.0 | ≤44 | ≤1.0 | ≤0.5 | ≤0.9 | ≤1.0 | Allowance |
| REMgSiFe-08-YA | 7.5≤RE＜8.5 | ≥50 | 7.0≤Mg＜9.0 | 1.0≤Ca＜3.0 | ≤44 | ≤1.0 | ≤0.5 | ≤0.9 | ≤1.0 | Allowance |
| For high toughness and heavy section ductile iron casting products, Ba, Bi, Sb may be added appropriately;  a：mainly including Y;  b：the content of total magnesium;  c：the content of magnesium oxide. | | | | | | | | | | |

5.2 Particle size of product

The product particle size ranges are 1 mm～5 mm, 5 mm～15 mm, 5 mm～25 mm, 5 mm～30 mm, 8 mm～40 mm. Products with particle size less than the lower limit should not exceed 5 % of the total weight and greater than the upper limit should also not exceed 5% of the total weight. By agreement between the supplier and purchaser, the particle size range with other special requirements can also be adopted.

5.3 Appearance quality

The appearance of product is blocky, not powdered, and the section should be silver-gray. No inclusions and oxidative shedding powder on the surface and section.

6 Test methods

6.1 Chemical composition

6.1.1 The analysis method of RE, La/RE, Ce/RE, Y/RE, Mg, MgO, Si, Mn, Ca and Ti content in the product shall be carried out according to GB/T 16477 (all parts).

6.1.2 The analysis method of Al content in the product shall be carried out according to GB/T 24194 (Al content in yttrium-base heavy ferrosilicon magnesium alloy shall be determined by standard curve method).

6.1.3 By agreement between the supplier and purchaser, the analysis method of Ba, Bi and Sb content in the product can also be adopted.

6.2 Particle size

The detection method of product particle size shall be carried out according to GB/T 13247.

6.3 Appearance quality

Visual inspection under naturally scattered light.

6.4 Rounding off numerical values

According to GB/T 8170.

7 Inspection rules

7.1 Inspection and acceptance

7.1.1 The product shall be inspected by the quality inspection department of the supplier or third party inspection. The quality of the product shall be as specified in this standard and the order, and the quality certificate shall be filled in.

7.1.2 The purchaser shall inspect the received product in accordance with this standard, and in case of the product have any discrepancy with this standard; the purchaser should inform the supplier of such discrepancy with in 2 month of receiving the product for settlement negotiation by both parties. If arbitration is needed, it can be entrusted to a unit recognized by both parties and sampling shall take place at the purchaser's premises with the participation of both parties.

7.2 Batching

Products shall be submitted for acceptance in batches, each batch shall be made up of the same designation and particle size range. Weight of each batch is not more than 2500 kg.

7.3 Inspection items

Each batch of products shall be inspected for chemical composition, particle size and appearance quality.

7.4 Sampling

7.4.1 Minimum weight of sample

The corresponding relations between minimum weight of sample and the specified maximum particle size of the batch of product shall be as specified in Table 3.

Table 3 Specified maximum particle size and minimum weight of sample

|  |  |
| --- | --- |
| Specified maximum particle size D  mm | minimum weight of sample  kg |
| D＞50 | 5 |
| 25≤D＜50 | 3.5 |
| 10≤D＜25 | 1.5 |
| D＜10 | 0.5 |

7.4.2 Minimum number of sample

Minimum number of sample shall be as specified in Table 4.

Table 4 Minimum number of sample

|  |  |
| --- | --- |
| Delivered bath  t | Minimum number of sample  pcs |
| 1～2.5 | 9 |
| 0.5～1 | 7 |
| 0～0.5 | 5 |

7.4.3 Sampling method

The sampling method usually adopts two-step sampling method, random sampling or systematic sampling may be used in the sampling process.

When the particle size of the package is quite different, the grid method shall be used for sampling.

7.4.4 Particle size sampling

Particle size sampling shall be carried out according to GB/T 13247.

7.5 Determination of inspection result

7.5.1 If the inspection result of chemical composition has any discrepancy with this standard, then double samples shall be taken from the same batch for repetitive inspection on nonconforming item; If any inspection result of chemical composition of the product is still fails, then this batch is determined as nonconforming product.

7.5.2 If the inspection result of particle size of the product has any discrepancy with this standard, this batch is determined as nonconforming product.

7.5.3 If the inspection result of appearance quality of the product has any discrepancy with this standard, this batch is determined as nonconforming product.

8 Packaging, Marking, Transportation, Storage and Accompanying Documents

8.1 Packaging

Product shall be packaged in woven bag with plastic bag inside. By agreement between the supplier and purchaser, the packaging with other special requirements can also be adopted.

8.2 Marking, Transportation and Storage

Marking, transportation and storage of product shall be carried out according to GB/T 39176.

8.3 Accompanying documents

Each batch of product shall be accompanied by accompanying documents. which should include a quality certificate, Quality certificate shall be carried out according to GB/T 39176. In addition, it should also include:

1. Product certification;
2. Inspection report during the product quality control process and inspection report of final product;
3. Product manual;

d）This standard number.

Bibliography

[1]GB/T 15676-2015 *Rare earth-Terms and definitions*