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Rare earth composite yttrium zirconium oxide ceramic powder

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*(English Translation）*

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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 standardization documents*.

This document replaces the GB/T 31968-2015 *Rare Earth Composite Yttrium-Zirconium Ceramic Powder* in whole. In addition to some editorial changes and structural adjustments，the following technical deviations have been made with respect to the GB/T 31968-2015 (*Rare Earth Composite Yttrium-Zirconium Ceramic Powder)(the previous edition*).

1. Modified the application fields of the products in the scope (see Chapter 1, Chapter 1 of the 2015 edition)
2. Modified the number and designations of product designations (see Chapter 4, 3.1 of the 2015 edition)
3. Modified the content of Y₂O₃ and Al₂O₃ corresponding to each product designation (see 5.1, 3.3 of the 2015 edition)
4. Modified the method of representation for ZrO₂,HfO₂ and the chemical composition content (see 5.1, 3.3 of the 2015 edition)
5. Added grade indicators for median particle sizes between 0.1 μm and 0.4 μm (see 5.2)
6. Modified the requirement of total radioactive activity and surface area. (see 5.2, 3.4 of the 2015 edition)
7. Modified analytical methods for the content of Y₂O₃, Fe₂O₃, Al₂O₃, Na₂O, TiO₂, and Cl⁻ (see 6.1, 4.2 of the 2015 edition)
8. Added test methods for total radioactivity activity (see 6.2.4)
9. Added sample pretreatment and preparation of analytical for determination ofSilicon Oxide Content in Rare Earth Composite Yttrium-Zirconium Ceramic Powder—Sample Pretreatment and Preparation of Analytical Test Solution (see Appendix A)
10. Added sample pretreatment and preparation of analytical for Determination of Chlorine Content in Rare Earth Composite Yttrium-Zirconium Ceramic Powder—Sample Pretreatment and Preparation of Analytical Test Solution have been added (see Appendix B)

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 and prepared by SAC/TC 229 (China Rare Earth Standardization Technical Committee).

This document was issued in 2015 as first edition, this is the first revision

Rare earth composite yttrium zirconium oxide ceramic powder

# 1 Scope

This document specifies the classification, technical requirements, inspection rules, labelling, packaging, transportation, storage, and accompanying documents for rare earth composite yttrium-zirconium ceramic powder, and describes the corresponding test methods.

This document is applicable to rare earth composite yttrium-zirconium ceramic powder produced by chemical or physical methods, which is used for manufacturing structural ceramics, bioceramics, electronic ceramics, etc.

# 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 6682 *Water for analytical laboratory use-Specification and test methods*

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

GB/T 12690.2 *Chemical analysis methods for non-rare earth impurity of rare earth metals and their oxides—Part 2: Determination of ignition loss content of rare earth oxides—Gravimetric method*

GB/T 12690.3 *Chemical analysis methods for non-rare earth impurity in rare earth metals and their oxides—Part 3: Determination of water content of rare earth oxides—Gravimetric Method*

GB/T 12690.7—2021 *Chemical analysis methods for non-rare earth impurities of rare earth metals and their oxides—Part 7: Determination of silicon content*

GB/T 12690.9 *Chemical analysis methods for non-rare earth impurities of rare earth metals andtheir oxides—Determination of chlorine content—Silver nitrate turbidimetric method*

GB/T 17803 *Designation system for rare earth products*

GB/T 20170.1—2006 *Test methods for physical characters of rare earth metals and their compounds Determination for particle size distribution of rare earth compounds*

GB/T 20170.2 *Test method of physical characters of rare earth metals and compounds Determination on specific surface area of rare earth compounds*

GB/T 31057.1 *Granular materials—The physical properties—Parts 1: Determination of apparent density*

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

GB/T 43358 *Rare earth mineral and rare earth products—Determination of gross alpha and beta radio activity—Thick source method*

XB/T 625 *Chemical analysis methods for rare earth composite yttrium-zirconium oxide ceramics—Determination of titanium Oxide, aluminum oxide, sodium oxide, and iron oxide contents*

XB/T 631 *Chemical analysis methods for rare earth composite yttrium-zirconium oxide ceramics—Determination of zirconium oxide, yttrium oxide and hafnium oxide contents*

# 3 Terms and definitions

There are no terms and definitions that need to be defined in this document.

# 4 Classification

The products are classified into 24 designations based on chemical composition and physical properties, as detailed in Table 1. The method for denoting product designation shall comply with the requirements of GB/T 17803.

Table 1 Product designation

| NO. | Product designation | NO. | Product designation |
| --- | --- | --- | --- |
| 1 | YZ-5.4QLA | 13 | YZ-8.8QLC |
| 2 | YZ-5.4QLB | 14 | YZ-8.8QLD |
| 3 | YZ-5.4QLC | 15 | YZ-8.8ZLA |
| 4 | YZ-5.4QLD | 16 | YZ-8.8ZLB |
| 5 | YZ-5.4QLE | 17 | YZ-8.8ZLC |
| 6 | YZ-5.4QLF | 18 | YZ-13.7QLA |
| 7 | YZ-5.4QLG | 19 | YZ-13.7QLB |
| 8 | YZ-5.4ZLA | 20 | YZ-13.7QLC |
| 9 | YZ-5.4ZLB | 21 | YZ-13.7QLD |
| 10 | YZ-5.4ZLC | 22 | YZ-13.7ZLA |
| 11 | YZ-8.8QLA | 23 | YZ-13.7ZLB |
| 12 | YZ-8.8QLB | 24 | YZ-13.7ZLC |
| **Note:** In the product designations, A, B, and C denote different specific surface areas; D, E, F, and G denote different central particle sizes. |

**5 Technical requirements**

5.1 **Chemical Composition**

The chemical composition of the product shall comply with the requirements in Table 2. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

Table 2 Chemical composition

| **Product designation** | **Moisture Content (wt**%**)** | L.O.I(**wt**%**)** | **Chemical Composition(wt**%**)** |
| --- | --- | --- | --- |
|  | Y2O3 | ZrO2**+**HfO2 | Fe2O3 | SiO2 | Al2O3 | Na2O | TiO2 | Cl- |
| YZ-5.4QLA | ≤1.0 | ≤1.0 | 5.40±0.30 | 94.30±0.60 | ≤0.002 | ≤0.01 | ≤0.5 | ≤0.01 | ≤0.005 | ≤0.02 |
| YZ-5.4QLB |
| YZ-5.4QLC |
| YZ-5.4QLD |
| YZ-5.4QLE |
| YZ-5.4QLF |
| YZ-5.4QLG |
| YZ-5.4ZLA | ≤4.0 |
| YZ-5.4ZLB |
| YZ-5.4ZLC |
| YZ-8.8QLD | ≤1.0 | 8.80±0.20 | 90.90±0.50 |
| YZ-8.8QLE |
| YZ-8.8QLF |
| YZ-8.8QLG |
| YZ-8.8ZLA | ≤4.0 |
| YZ-8.8ZLB |
| YZ-8.8ZLC |
| YZ-13.7QLD | ≤1.0 | 13.70±0.30 | 86.00±0.60 |
| YZ-13.7QLE |
| YZ-13.7QLF |  |
| YZ-13.7QLG |  |
| YZ-13.7ZLA | ≤4.0 |
| YZ-13.7ZLB |
| YZ-13.7ZLC |
| **Note 1:** The content of yttrium oxide with mass fraction of 5.40%, 8.80% and 13.70% is 3mol, 5mol and 8mol，respectively. The conversion formula between the molar amount of yttrium oxide and mass fraction is as follows: $m=\frac{225.8n}{225.8n+123.2×\left(100-n\right)}×100\%$**Where:***n* is the molar amount of yttrium oxide molecules (mol)*m* is the mass fraction of yttrium oxide molecules (%)**Note 2:** The contents of Y₂O₃, ZrO₂, and HfO₂ in the granulated powder (ZL) are determined after ignition loss. |

5.2 Physical Properties

The physical properties of the product shall comply with the requirements in Table 3. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

Table 3 Physical properties

| Product designation | Median Particle Size（D50))μm | Apparent Density（ρac）g/cm3 | Surface Area (BET)m2/g | Total Specific Activity (Bq/g) |
| --- | --- | --- | --- | --- |
| YZ-5.4QLA | ≤0.1 | — | 5～10 | ≤1.0 |
| YZ-5.4QLB | ＞10～18 |
| YZ-5.4QLC | ＞18 |
| YZ-5.4QLD | ＞0.1～0.4 | — | ＞7～18 |
| YZ-5.4QLE | ＞0.4～0.6 | — | ＞7～13 |
| YZ-5.4QLF | ＞0.6～1.0 | — |
| YZ-5.4QLG | ＞1.0～1.3 | — |
| YZ-5.4ZLA | — | ＞1.2～1.45 | ＞5～10 |
| YZ-5.4ZLB | ＞10～18 |
| YZ-5.4ZLC | ＞18 |
| YZ-8.8QLD | ＞0.1～0.4 | — | ＞7～18 |
| YZ-8.8QLE | ＞0.4～0.6 | — | ＞7～13 |
| YZ-8.8QLF | ＞0.6～1.0 | — |
| YZ-8.8QLG | ＞1.0～1.3 | — |
| YZ-8.8ZLA | — | ＞1.2～1.45 | ＞5～10 |
| YZ-8.8ZLB | ＞10～18 |
| YZ-8.8ZLC | ＞18 |
| YZ-13.7QLD | ＞0.1～0.4 | — | ＞7～18 |
| YZ-13.7QLE | ＞0.4～0.6 | — | ＞7～13 |
| YZ-13.7QLF | ＞0.6～1.0 | — |
| YZ-13.7QLG | ＞1.0～1.3 | — |
| YZ-13.7ZLA  | — | ＞1.2～1.45 | ＞5～10 |
| YZ-13.7ZLB  | ＞10～18 |
| YZ-13.7ZLC | ＞18  |

5.3 Appearance Quality

The product shall be a clean white powder, free of visibly detectable inclusions.

6 Test methods

6.1 Chemical composition

6.1.1 Determination of moisture content shall be carried out in accordance with GB/T 12690.3.
6.1.2 Determination of ignition loss shall be carried out in accordance with GB/T 12690.2.

6.1.3 Determination of yttrium oxide (Y₂O₃), zirconium oxide + hafnium oxide (ZrO₂+HfO₂) contents shall be carried out in XB/T 631. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

6.1.4 Determination of iron oxide (Fe₂O₃), aluminum oxide (Al₂O₃), sodium oxide (Na₂O), and titanium oxide (TiO₂) contents shall be carried out in XB/T 625. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

6.1.5 Determination of silicon dioxide (SiO₂) content, sample pretreatment and preparation of analytical test solutions shall be carried out in accordance with the rules given in Annex A, and other parts shall be carried out in accordance with Method 1 of GB/T 12690.7—2021.
6.1.6 Determination of chloride (Cl⁻) content, sample pretreatment and preparation of analytical test solutions shall be carried out in accordance with the rules given in Annex B, and other parts shall be carried out in accordance with GB/T 12690.9.

6.2 Physical Properties
6.2.1 The determination of median particle size shall be carried out in accordance with GB/T 20170.1—2006.
6.2.2 The determination of apparent density shall be carried out in accordance with GB/T 31057.1.
6.2.3 The determination of surface area shall be carried out in accordance with GB/T 20170.2.
6.2.4 The determination of total radioactive specific activity shall be carried out in accordance with GB/T 43358.

6.3 Appearance quality
Appearance quality shall be inspected visually under natural scattered light.

7 Inspection rules

7.1 Inspection and acceptance
7.1.1 The supplier or a third-party shall inspect the product, and provide the quality certificate.

7.1.2 The buyer shall inspect the quality of the product received in accordance with the rules given in this document. If the testing results don’t meet this document, notification of the discrepancies shall be informed to the supplier within two months from the date of receipt of products. Both parties shall be taken by the both parties on the buyer side. resolve it through negotiation. In case of arbitration, the matter may be entrusted to a mutually recognized institution, and joint sampling shall be conducted at the buyer's premises.

7.2 Batching
Products shall be submitted in batches for inspection, and each batch of products shall be of the same designation, and the weight of each batch shall not exceed 1000 kg. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

7.3 Inspection items
The chemical composition, physical properties and appearance quality shall be inspected for each batch of products.

7.4 Sampling and sample preparation

The number of sampling for product shall comply with the requirements in Table 4. Using a sampling tube, take three points (center and two equidistant peripheral points) from each bag, ensuring a minimum sample weight of 100g per bag. Mix the samples thoroughly in a plastic bag, the sample shall be immediately reduced to the required amount by quartering method and packed into a clean plastic bottle (bag) and sealed.

**Table 4 Number of sampling**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Bags/Containers | 1～5 | 6～49 | 50～100 | ＞100 |
| Number of Sampling Units | 100% of the Bags/Containers | 5 | 10% of the Number of Bags/Containers, Rounded Up to the Nearest Integer | Square Root of the Number of Bags/Containers, Rounded Up to the Nearest Integer |

7.5 Judgement of inspection results

7.5.1 The numerical values of inspection results shall be rounded off in accordance with GB/T 8170.
7.5.2 If the analytical test results of chemical composition, physical properties, or appearance quality of the product has any discrepancy with the requirements of this document, the batch of products shall be deemed non-conforming.

8 Labelling, packaging, transportation, storage, and accompanying documents

8 1 Labelling, packaging, transportation, storage

The labelling, packaging, transportation, and storage of the product shall comply with the provisions of GB 39176. The net weight per bag shall be 25 kg, 30 kg, or 50 kg. If the buyer has any special requirements, it shall be negotiated by the supplier and buyer.

8.2 Accompanying documents

Each batch of products shall be accompanied by documents, which shall include a quality certificate conforming to the provisions of GB 39176. Additionally, the following documents should preferably be included:
a) Product certificate of conformity;
b) Inspection reports from the product quality control process and final inspection reports;
c) Product instruction manual;
d) Other relevant documents.

Annex A

（Normative）

Determination of silicon oxide content in rare earth composite Yttria- Zirconia oxide Ceramic Powder

Sample Pretreatment and Preparation of Analytical Test Solution

A.1 Reagents

Unless otherwise specified, only analytical grade or higher reagents confirmed to be suitable shall be used in the analysis.

A.1.1 Water, grade II water specified in GB/T 6682

A.1.2 Boric acid, GR

A.1.3 Hydrofluoric acid (ρ=1.15 g/mL), GR

A.1.4 Nitric acid (1+1)

A.2 Apparatus

A.2.1 Microwave high-pressure digestion system

A.2.2 Oven, capable of maintaining 105°C ±5°C.

A.3 Sample

The test sample shall be dried at 105°C in oven for 1 hour,then placed in a desiccator, cooled to room temperature, and weighed immediately.

A.4 Procedure

A.4.1 Test portion

Weigh 0.20 g of the sample (A.3), accurate to 0.0001 g.

A.4.2 Parallel tests

Weigh two test portion for parallel determination, calculate the mean value.

A.4.3 Blank test

Carry out blank test with the test portion (A.4.1).

A.4.4 Preparation of analytical test solution

Place the test portion (A.4.1) into a PTFE crucible of the microwave high-pressure digestion system (A.2.1). Add 2 mL of hydrofluoric acid (A.1.3) and 5 mL of nitric acid (A.1.4). Cover the crucible and tighten the high-pressure sleeve. Maintain at 160°C ±10°C for 50 minutes until the sample is dissolved. Remove and allow to cool slightly. Add 20 mL of water (A.1.1) and 2.0 g of boric acid (A.1.2), then heat to dissolve in a boiling water bath. Cool the solution, transfer to a 50 mL plastic volumetric flask, dilute to the mark with water (A.1.1), and mix thoroughly.
Pipette 10.00 mL of the test solution into a 100 mL PTFE beaker for analysis.

 Annex B

(Normative)

Determination of chloride content in Rare Earth Composite Yttria- Zirconia Ceramic Powder

Sample Pretreatment and Preparation of Analytical Test Solution

B.1 Reagents and Materials

Unless otherwise specified, only analytical grade or higher reagents confirmed to be suitable shall be used in the analysis.

B.1.1 Water, Grade II water specified in GB/T 6682

B.1.2 Hydrofluoric acid (ρ=1.15 g/mL), GR

B.1.3 Nitric acid (1+1)

B.2 Apparatus

B.2.1 Microwave high-pressure digestion system

B.2.2 Oven, capable of maintaining 105°C ±5°C

B.3 Sample

B.4 Procedure

B.4.1 Test portion

Weigh 0.30 g of the sample (B.3), accurate to 0.0001 g.

B.4.2 Parallel Tests

Weigh two test portions for parallel determination, calculate the mean value.

B.4.3 Blank Test

Carry out blank test with the test portion (B.4.1).

B.4.4 Preparation of Analytical Test Solution

Place the test sample (B.4.1) into a PTFE crucible of the microwave high-pressure digestion system. Add 2 mL of hydrofluoric acid (B.1.2) and 5 mL of nitric acid (B.1.3). Cover the crucible and tighten the high-pressure sleeve. Maintain at 160°C ±10°C for 50 minutes until the sample is dissolved. After cooling, transfer the solution from the crucible to a 25 mL plastic volumetric flask, dilute to the mark with water (B.1.1), and mix thoroughly.
Filter the solution dries into a 50 mL beaker. Pipette 10 mL of the filtrate into a 25 mL colorimetric tube, add 2 mL of nitric acid (B.1.3) for analysis.