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**High strength Magnesium Alloy Bars**

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**高强度镁合金棒材**

**（English Translation）**

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 Standardization Administration of the People’s Republic of China

Foreword

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

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009.

This standard was proposed by the China Nonferrous Metals Industry Association.

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High strength Magnesium Alloy Bars

1. Scope

This standard specifies the technical requirements, test methods, inspection rules and marking, packaging, transport, storage, quality certificates and order forms (or contracts) of high-strength magnesium alloy bars.

This standard is applicable to the extruded magnesium alloy round bars, square bars and hexagonal bars (hereinafter referred as bars) with the ultimate tensile strength no less than 350 MPa at room temperature.

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 referenced document (including any amendments) applies.

GB/T 4297 Inspection method for macrostructure of wrought magnesium alloy products

GB/T 5153 Designation and composition of wrought magnesium and magnesium alloys

GB/T 5155-2013 Magnesium alloy extruded bars

GB/T6519-2013 Ultrasonic inspection of wrought aluminum and magnesium alloy products

GB/T 13748 (All parts) Chemical analysis methods of magnesium and magnesium alloys

GB/T 16865 Test pieces and method for tensile test for wrought aluminum and magnesium alloys products

GB/T 17432 Methods for sampling for analyzing the chemical composition of wrought aluminum and aluminum alloy

GB/T 20967 Non-destructive testing Visual testing

GB/T 32792 Packing, marking, transporting and storing magnesium alloy wrought products

GB/T 37596-2019 Magnesium alloy forgings for aerospace

YS/T 627 Wrought magnesium and magnesium alloys rotundity ingots

YS/T 1036 The method of optical emission spectrometric analysis of magnesium rare earth alloys

1. Technical requirements

3.1 Classification

3.1.1 Designation, temper and dimension

The designation, temper and dimension of the bars shall conform to the provisions in Table 1. If the demander needs other designation, temper and dimension, it shall be agreed by both parties and specified in the order form (or contract).

Table 1 Designation, temper and dimension

|  |  |  |
| --- | --- | --- |
| Designation | Temper | Dimension a /mm |
| VW75M, VW93M | T5 | ≤160 |
| VW83M | T5 | ≤100 |
| AQ80M | T6 | ≤160 |
| WN54M | H112 |
| VW84M, VW94M, VW84N | H112, T5 |
| VW92 | H112, T5, T6 | ≤50 |
| a Dimension of round bar stands for the diameter of the bar, dimension of square bar and hexagonal bar stands for the diameter of inscribed circle of the bar  |

3.1.2 Marking

Markings shall be expressed in the order of product name, standard number, designation temper, and dimension. Examples of markings are as follows:

Example 1:

AQ80M alloy, H112, with 40mm in diameter, with 3500mm in length, marked as:

Round bar GB/T 38715-AQ80M H112-Φ40×3500

Example 2:

VW75M alloy, T5, with 40mm in inscribed circle diameter, Class A precision unfixed hexagon bar, marked as:

Hexagon bar GB/T 38715-VW75M T5-120-A

3.2 Quality

3.2.1 Raw material

Ingot used to produce high-strength magnesium alloy shall meet the composition and macrostructure requirements of the bar as specified in this standard, and other quality of ingot shall comply with YS/T 627.

3.2.2 Production process

The supplier shall adopt proper production equipment and extrusion process to effectively guarantee the quality of the bar, and the extrusion ratio should not be less than 6.

3.3 Chemical composition

The chemical composition of VW93M, VW94M, VW84N, WN54M and VW92 bars shall comply with the provisions of Table 2, and the chemical composition of other alloy bars shall comply with the provisions of GB/T 5153.

Table 2 Chemical composition

| Alloy group | Designation | Chemical composition (wt%) |
| --- | --- | --- |
| Mg | Zn | Mn | RE | Gd | Y | Zr | Ag | Si | Fe | Cu | Ni | Other Elements |
| Each | Total |
| MgGdYZr | VW93M | Rem. | - | - | 0.02～0.30Er | 8.0～9.6 | 1.8～3.2 | 0.3～0.7 | 0.02～0.50 | 0.02 | 0.02 | 0.005 | 0.003 | 0.01 | 0.1 |
| MgGdYZnZr | VW94M | Rem. | 0.8～1.5 | - | - | 8.5～9.5 | 3.5～4.5 | 0.4～0.7 | - | - | 0.005 | 0.005 | 0.005 | 0.02 | 0.3 |
| MgGdYNiMn | VW84N | Rem. | - | 0.6～1.0 | - | 7.9～9.0 | 3.5～5.0 | - | - | 0.05 | 0.01 | 0.02 | 1.0～3.0 | 0.02 | 0.2 |
| MgNiY | WN54M | Rem. | - | - | - | - | 4.5～6.0 | - | - | 0.05 | 0.01 | 0.02 | 3.5～5.0 | 0.02 | 0.2 |
| MgGdYZnNdZr | VW92 | Rem. | 1.6～2.4 | - | 0.7～1.4Nd | 8.8～9.8 | 1.6～2.4 | 0.4～1.0 | - | - | 0.01 | 0.02 | 0.005 | 0.02 | 0.2 |

3.4 Dimension deviation

The allowable deviation of the bar shall comply with the dimension requirements of grade B as specified in GB/T 5155-2013, and the dimension deviation of other precision levels shall be agreed by both parties and noted in the purchase order (or contract).

3.5 Tensile properties at room temperature

The longitudinal tensile properties of the bar at room temperature shall comply with the provisions of Table 3. The mechanical properties of bars exceeding the requirements in Table 3 shall be agreed by both parties and noted in the order form (or contract).

Table 3 Tensile properties at room temperature

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Designation | Dimensionamm | Temper | Tensile strength *R*mMPa | 0.2 % Proof stress *R*p0.2MPa | Elongation*A*% |
| No less than |
| AQ80M | ≤80 | T6 | 370 | 260 | 4.0 |
| ＞80~160 | T6 | 365 | 240 | 3.0 |
| VW75M | ≤80 | T5 | 430 | 350 | 5.0 |
| ＞80~160 | T5 | 350 | 250 | 3.0 |
| VW83M | ≤100 | T5 | 420 | 320 | 8.0 |
| VW84M | ≤65 | H112 | 380 | 270 | 9.0 |
| T5 | 460 | 360 | 3.0 |
| ＞65~160 | H112 | 360 | 230 | 9.0 |
| T5 | 440 | 350 | 3.0 |
| VW93M | ≤160 | T5 | 350 | 280 | 5.0 |
| VW94M | ≤80 | H112 | 360 | 280 | 10.0 |
| T5 | 400 | 310 | 8.0 |
| ＞80~160 | H112 | 350 | 260 | 8.0 |
| T5 | 380 | 300 | 5.0 |
| VW84N | ≤80 | H112 | 370 | 260 | 6.0 |
| T5 | 450 | 340 | 3.0 |
| ＞80~160 | H112 | 350 | 240 | 6.0 |
| T5 | 440 | 320 | 3.0 |
| WN54M | ≤80 | H112 | 370 | 280 | 10.0 |
| ＞80~160 | H112 | 350 | 260 | 6.0 |
| VW92 | ≤50 | H112 | 350 | 280 | 10.0 |
| T5 | 360 | 260 | 8.0 |
| T6 | 380 | 270 | 6.0 |
| a Dimension of round bar stands for the diameter of the bar, dimension of square bar and hexagonal bar stands for the diameter of inscribed circle of the bar |

3.6 Macrostructure

3.6.1 Cracks, inclusions (including flux slag), pores, primary crystal segregation, shrinkage tail, coarse crystal ring and other defects which damage the continuity of metal are not allowed on the macrostructure sample of the bars.

3.6.2 Lamination with a depth of no more than half of the negative deviation of the diameter is allowed on the macrostructure sample of the bars. If no lamination is required, it shall be agreed by both parties and specified in the order form (or contract).

3.6.3 The demander has requirements for macro oxide film, metal compound, and manganese compound, it shall be agreed by both parties and specified in the order form (or contract). The macro oxide film, metal compound, and manganese compound shall comply with the provisions of 3.6 in GB/ T 37596-2019.

3.7 Ultrasonic flaw detection

Ultrasonic flaw detection of the bar shall meet the requirements of grade A in GB/ T 6519-2013. If other defect detection grades are needed, it shall be specified in the order form (or contract) after negotiation by both parties.

3.8 Appearance

3.8.1 The surface of the bars shall be clean, and defects such as cracks, corrosion spots, and various intrusions that affect the usage are not allowed.

3.8.2 Defects with the depth not exceeding a negative deviation, such as extrusion trail, dent, bruise, bubble, abrade, scratch, convex and concave, are allowed on the surface of the bars.

4 Test method

4.1 Chemical composition

The chemical composition of the bar shall be tested in accordance with GB/T 13748 or YS/T 1036, and GB/T 13748 shall be adopted for the arbitration analysis.

4.2 Dimension deviation

The dimensional deviation shall be measured with a measuring instrument of the corresponding accuracy.

4.3 Tensile properties at room temperature

The test for the longitudinal mechanical property of the bars at room temperature shall be in accordance with GB/T 16865.

4.4 Macrostructure

The test methods for macrostructure of the bars shall be in accordance with GB/T 4297.

4.5 Ultrasonic flaw detection

The test methods for ultrasonic flaw detection of the bars shall be in accordance with GB/T 6519-2013.

4.6 Appearance

The test methods for appearance of the bars shall be in accordance with GB/T 20967.

5 Inspection rules

5.1 Inspection and acceptance

5.1.1 The bars shall be inspected by the supplier to ensure that the quality of the bar conforms to the requirements of this standard and the purchase order (or contract), and fill in the quality certificate.

5.1.2 The demander shall inspect the received bars following the provisions of this standard. If the inspection results are inconsistent with the requirements of this standard and the purchase order (or contract), they shall be submitted to the supplier in written form. The determination shall be made through consultation between the supplier and the demander. Objections that belong to the surface quality or external dimensions shall be filed within one month from the date of receiving the bars. Other objections shall be filed within three months from the date of receiving the bars. If arbitration is needed, it shall be determined through consultation between the supplier and the demander.

5.2 Batch

Bars shall be delivered for acceptance in batches, and each batch shall consist of sections of the same alloy designation, the same temper, the same dimensions, the same melt, the same heat treatment furnace and the same extrusion lot. The batch weight is not limited.

5.3 Inspection item

Before leaving the factory, each batch of bar materials shall be inspected for chemical composition, dimension deviation, tensile property at room temperature, macrostructure, ultrasonic inspection and appearance.

5.4 Sampling

The sampling of bar shall comply with Table 4.

Table 4 Sampling requirements

|  |  |  |  |
| --- | --- | --- | --- |
| Inspection items | Sampling rules | Required chapter number | Chapter number of test method |
| Chemical composition | According to GB/T 17432, choose one sample from each batch | 3.3 | 4.1 |
| Dimensional deviation | Inspected one by one | 3.4 | 4.2 |
| Room temperature mechanical property | Take 10% of bars in each batch, no less than two samples, and cut one sample in the front of the extruded bar | 3.5 | 4.3 |
| Macrostructure | Take 10% of bars in each batch, no less than two samples, and cut one sample in the tail end of the extruded bar | 3.6 | 4.4 |
| Ultrasonic flaw detection | Inspected one by one | 3.7 | 4.5 |
| Appearance  | Inspected one by one | 3.8 | 4.6 |

5.5 Judgment of inspection result

5.5.1 If the chemical composition of any sample is unqualified, the batch shall be judged unqualified.

5.5.2 If the dimension deviation is unqualified, the bar is judged unqualified.

5.5.3 If the mechanical property of any sample is unqualified, double number of samples from the batch of bars shall be taken for repeated tests. If all the results of the repeated tests are qualified, the batch of products is judged qualified. If one of the samples in the repeated test is still unqualified, the batch of bars is judged unqualified.

5.5.4 If the macrostructure of any sample is unqualified, it shall be judged as follows:

a) When the samples have unqualified cracks, oxide films, segregation of metal compounds and manganese compounds, the batch shall be rejected.

b) When the samples have unqualified tail shrinking, coarse crystal ring, bright ring and lamination, it is allowed to repeat the test after cutting off a certain length of the unqualified bar until qualified. Other bars shall be either inspected one by one and the qualified bar can be delivered, or cut the bars with maximum unqualified length from the retest and then delivery. In case of other defects, the batch of bars shall be negotiated by both parties.

5.5.5 If the ultrasonic flaw detection is unqualified, the bar is judged unqualified.

5.5.6 If the appearance is unqualified, the bar is judged unqualified.

6 Marking, packaging, transportation and storage, quality certificate

6.1 Marking

6.1.1 Product marking

6.1.1.1 The following marking shall be stamped in the front of the qualified bar (or a label with the following marking):

a) Stamp of the supplier's technical supervision department;

b) Alloy designation;

c) Temper;

d) Dimension;

e) Batch number.

6.1.1.2 For the bars with accepted diameter more than or equal to 20 mm, the word “W” shallbe marked in the end of the extrusion.

6.1.2 Packaging marking

The marking of the packaging box of the bars shall conform to GB/T 32792.

6.2 Packaging, transportation and storage

6.2.1 Bars shall be oiled and packaged. If there are special requirements, it shall be negotiated between the supplier and the demander, and specified in the order form (or contract).

6.2.2 Other requirements for the packaging, transportation and storage of bars shall conform to GB/T 32792.

6.3 Quality certificate

Each batch of bars shall be accompanied by a bar quality certificate, which states:

a) Supplier name, address, telephone, fax;

b) Product designation;

c) Alloy designation;

d) Temper;

e) Dimension and accuracy levels;

f) Batch number;

g) Net weight and number of packages;

h) All inspection results;

i) Stamp of the supplier's technical supervision department;

j) This standard number;

k) Packaging date (or manufacturing date).

7 Order form (or contract)

The following items shall be included in the order form (or contract) for the products listed in this standard:

a) Product designation;

b) Alloy designation;

c) Temper;

d) Dimensions and allowable dimension deviation;

e) Net weight or number of packages;

f) Special requirements of demander:

——Special dimensional deviation requirements;

——Special requirements for tensile properties;

——Special packing requirements;

——Other special requirements;

g) This standard number;

h) Others.