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**GB/T 3623—2022**

(replacing GB/T 3623—2007)

# Titanium and titanium alloy wire

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# Foreword

This document was drafted in accordance with the rules given in GB/T 1.1—2020 "Directives for standardization — Part 1: Structure and drafting rules for standardization documents".

This document replaces GB/T 3623—2007 "Titanium and titanium alloy wire". Compared with GB/T 3623—2007, apart from structural adjustments and editorial changes, the main technical changes are as follows:

a) "Material" was deleted (see 3.3 of the 2007 edition);

b) The technical requirements for TA1, TA2 and TA3 products were changed; TA1ELI, TA2ELI, TA3ELI, TA4 and TA4ELI were deleted; technical requirements for TA0, TA1GELI, TA1G, TA1G-1, TA2GELI, TA2G, TA3GELI, TA3G, TA4GELI, TA4G, TA8, TA8-1, TA9-1, TA18, TA22, TA23, TA24, TA31 and TA36 products were added (see Table 1, Table 2 and Table 3, and Tables 1, 2 and 4 of the 2007 edition);

c) The specification ranges of the products were changed (see Table 1, Table 2 and Table 3, and Tables 1, 2 and 4 of the 2007 edition);

d) A requirement for the proof strength (non-proportional extension) was added (see Table 3, and Table 4 of the 2007 edition);

e) The requirements for the dimensions and their permissible deviations of the wire were changed (see 5.2, and 3.5 of the 2007 edition);

f) The requirements for the purchase order were changed (see Clause 9, and Clause 7 of the 2007 edition);

g) The analytical methods for chemical composition were changed (see 6.1, and 4.1 of the 2007 edition);

h) The test methods for the dimensions and their permissible deviations were changed (see 6.2, and 4.2 of the 2007 edition);

i) "Quality certificate" was changed to "accompanying documents" (see 8.3, and 6.3 of the 2007 edition);

j) The requirements for the purchase order were changed (see Clause 9, and Clause 7 of the 2007 edition);

k) Annex A was deleted (see Annex A of the 2007 edition).

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 by the China Nonferrous Metals Industry Association.

This document is under the jurisdiction of the National Nonferrous Metals Standardization Technical Committee (SAC/TC 243).

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This document was first issued in 1983, first revised in 1998, second revised in 2007, and this is the third revision.

## 1 Scope

This document specifies the classification and designation, technical requirements, test methods, inspection rules, marking, packaging, transport, storage, accompanying documents and contents of the purchase order for titanium and titanium alloy wire (hereinafter referred to as wire).

This document applies to round wire used for the manufacture of structural parts, electrode materials and welding consumables.

## 2 Normative References

The following documents contain provisions which, through normative reference in this document, constitute indispensable provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition (including all amendments) applies.

| Standard No. | Title |
|---|---|
| GB/T 228.1 | Metallic materials — Tensile testing — Part 1: Method of test at room temperature |
| GB/T 3620.1 | Designation and composition of titanium and titanium alloys |
| GB/T 3620.2 | Permissible deviations in chemical composition for wrought titanium and titanium alloy products |
| GB/T 4698 (all parts) | Methods for chemical analysis of titanium sponge, titanium and titanium alloys |
| GB/T 5168 | Methods for macrostructure and microstructure examination of titanium and titanium alloys |
| GB/T 6611 | Terminology and metallographs for titanium and titanium alloys |
| GB/T 8180 | Packaging, marking, transport and storage of wrought titanium and titanium alloy products |
| GB/T 38982 | Method for measuring dimensions of wrought titanium and titanium alloy products |
| GB/T 39799—2021 | Dimensions, shape, weight and permissible deviations of titanium and titanium alloy bars and wires |
| YS/T 1262 | Methods for chemical analysis of titanium sponge, titanium and titanium alloys — Determination of multi-element content — Inductively coupled plasma atomic emission spectrometry |

## 3 Terms and Definitions

For the purposes of this document, the terms and definitions given in GB/T 6611 and GB/T 38982 apply.

# 4 Classification and Designation

## 4.1 Product Classification

**4.1.1**

The products are classified into two categories according to use:

——wire for structural parts, i.e. wire mainly used for structural parts;

——welding wire, i.e. wire mainly used as electrode material and welding consumable.

**4.1.2**

The designations, conditions and specifications of the products shall conform to the requirements of Table 1.

**Table 1 — Designations, conditions and specifications**

| Designation | Condition | Diameter/ mm |
|---|---|---|
| TA0, TA1, TA2, TA3, TA1GELI, TA1G, TA2GELI, TA2G, TA3GELI, TA3G, TA4GELI, TA4G, TA7, TA8, TA8-1, TA9, TA9-1, TA10, TA18, TA22, TA23, TA24, TA28, TA31, TA36, TC1, TC2, TC3 | Hot-worked (R), cold-worked (Y), annealed (M) | 0.1~7.0 |
| TA1G-1, TC4, TC4ELI | | 0.8~7.0 |

NOTE: The use and condition of the wire shall be stated in the purchase order; when not stated, the wire shall be supplied as welding wire in the worked condition (Y or R).

## 4.2 Product Designation

The product designation shall be expressed in the order of product name, designation, condition, specification and document number.

Example 1: wire manufactured from designation TA2, in the annealed condition, with a diameter of 3.0 mm, is designated as:

Wire TA2 M φ3 mm GB/T 3623—××××

Example 2: wire manufactured from designation TA1, in the hot-worked condition, with a diameter of 4.5 mm, is designated as:

Wire TA1 R φ4.5 mm GB/T 3623—××××

# 5 Technical Requirements

## 5.1 Chemical Composition

### 5.1.1

The chemical composition of wire for structural parts shall conform to the provisions for the corresponding designations in GB/T 3620.1; the chemical composition of welding wire shall conform to the requirements of Table 2.

### 5.1.2

When the purchaser takes samples from the product for re-verification of the chemical composition, the permissible deviations of the chemical composition shall conform to the provisions of GB/T 3620.2.

**Table 2 — Chemical composition of welding wire**

| Designation | Ti | Al | Mn | V | Sn | Pd | Mo | Ni | Fe | O | C | N | H |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TA0 | Balance | — | — | — | — | — | — | — | 0.10 | 0.10 | 0.05 | 0.03 | 0.012 |
| TA1 | Balance | — | — | — | — | — | — | — | 0.20 | 0.15 | 0.05 | 0.03 | 0.012 |
| TA2 | Balance | — | — | — | — | — | — | — | 0.25 | 0.20 | 0.05 | 0.05 | 0.012 |
| TA3 | Balance | — | — | — | — | — | — | — | 0.35 | 0.25 | 0.05 | 0.05 | 0.012 |
| TA1G-1 | Balance | ≤0.20 | Si ≤0.08 | | — | — | — | — | 0.15 | 0.12 | 0.05 | 0.03 | 0.003 |
| TA1G | Balance | — | — | — | — | — | — | — | 0.15 | 0.12 | 0.05 | 0.03 | 0.012 |
| TA1GELI | Balance | — | — | — | — | — | — | — | 0.08 | 0.10 | 0.03 | 0.012 | 0.005 |
| TA2G | Balance | — | — | — | — | — | — | — | 0.20 | 0.18 | 0.05 | 0.03 | 0.012 |
| TA2GELI | Balance | — | — | — | — | — | — | — | 0.12 | 0.16 | 0.03 | 0.015 | 0.008 |
| TA3G | Balance | — | — | — | — | — | — | — | 0.25 | 0.25 | 0.05 | 0.05 | 0.012 |
| TA3GELI | Balance | — | — | — | — | — | — | — | 0.16 | 0.20 | 0.03 | 0.02 | 0.008 |
| TA4G | Balance | — | — | — | — | — | — | — | 0.30 | 0.35 | 0.05 | 0.05 | 0.012 |
| TA4GELI | Balance | — | — | — | — | — | — | — | 0.25 | 0.32 | 0.03 | 0.025 | 0.008 |
| TA7 | Balance | 4.0~6.0 | — | — | 2.0~3.0 | — | — | — | 0.45 | 0.15 | 0.05 | 0.05 | 0.012 |
| TA9 | Balance | — | — | — | — | 0.12~0.25 | — | — | 0.20 | 0.18 | 0.05 | 0.03 | 0.012 |
| TA10 | Balance | — | — | — | — | — | 0.2~0.4 | 0.6~0.9 | 0.25 | 0.20 | 0.05 | 0.03 | 0.012 |
| TA18 | Balance | 2.0~3.5 | — | 1.5~3.0 | — | — | — | — | 0.20 | 0.12 | 0.03 | 0.015 | 0.005 |
| TA22 | Balance | 2.0~3.0 | Zr 0.5~1.0 | | — | — | 0.2~0.8 | 0.3~0.8 | 0.15 | 0.10 | 0.10 | 0.04 | 0.008 |
| TA23 | Balance | 2.0~3.0 | Zr 1.7~2.3 | | — | — | Fe 0.8~1.1 | | — | 0.10 | 0.10 | 0.04 | 0.008 |
| TA24 | Balance | 1.5~2.5 | Zr 1.0~3.0 | | — | — | 1.0~2.0 | — | 0.15 | 0.10 | 0.10 | 0.04 | 0.008 |
| TA28 | Balance | 2.0~3.0 | — | — | — | — | — | — | 0.30 | 0.15 | 0.05 | 0.04 | 0.012 |
| TA31 | Balance | 4.5~5.5 | Si ≤0.04 | | Nb 1.6~2.3 | Zr 1.6~2.3 | 0.35~0.65 | — | 0.15 | 0.10 | 0.10 | 0.04 | 0.010 |
| TA36 | Balance | 0.4~1.0 | Si ≤0.04 | | Fe 0.6~1.0 | — | — | — | — | 0.10 | 0.10 | 0.04 | 0.010 |
| TC1 | Balance | 1.0~2.5 | 0.7~2.0 | — | — | — | — | — | 0.30 | 0.15 | 0.10 | 0.05 | 0.012 |
| TC2 | Balance | 3.5~5.0 | 0.8~2.0 | — | — | — | — | — | 0.30 | 0.15 | 0.10 | 0.05 | 0.012 |
| TC3 | Balance | 4.5~6.0 | — | 3.5~4.5 | — | — | — | — | 0.25 | 0.15 | 0.05 | 0.05 | 0.012 |
| TC4 | Balance | 5.5~6.75 | — | 3.5~4.5 | — | — | — | — | 0.25 | 0.18 | 0.05 | 0.05 | 0.012 |
| TC4ELI | Balance | 5.5~6.5 | — | 3.5~4.5 | — | — | — | — | 0.20 | 0.03~0.11 | 0.03 | 0.012 | 0.005 |

NOTE 1: For TA1GELI, TA2GELI, TA3GELI and TA4GELI, the individual content of Al, V and Sn shall not be greater than 0.05%, and the total shall not be greater than 0.2%.

NOTE 2: * Other impurity elements shall conform to the provisions for the corresponding designations in GB/T 3620.1.

## 5.2 Dimensions and Their Permissible Deviations

### 5.2.1

The wire is supplied in loose coils. When required by the purchaser and stated in the purchase order, the welding wire may be supplied re-wound on spools (reels).

### 5.2.2

When required by the purchaser and stated in the purchase order, wire with a diameter of not less than 1.0 mm may be supplied as straight wire.

### 5.2.3

The dimensions and their permissible deviations of the wire shall conform to the provisions of GB/T 39799—2021, of which the permissible deviations of diameter shall conform to the provisions of Grade I in GB/T 39799—2021.

## 5.3 Tensile Properties

After heat treatment, the room-temperature tensile properties of wire for structural parts shall conform to the requirements of Table 3.

**Table 3 — Room-temperature tensile properties**

| Designation | Diameter/ mm | Tensile strength Rm/MPa | 0.2% proof strength (non-proportional extension) Rp0.2[a]/MPa | Percentage elongation after fracture A[b]/% |
|---|---|---|---|---|
| TA0 | 0.1~7.0 | ≥280 | ≥170 | ≥20 |
| TA1 | 0.1~7.0 | ≥370 | ≥250 | ≥18 |
| TA2 | 0.1~7.0 | ≥440 | ≥320 | ≥15 |
| TA3 | 0.1~7.0 | ≥540 | ≥410 | ≥15 |
| TA1G | 0.1~7.0 | ≥240 | ≥140 | ≥20 |
| TA1G-1 | 0.8~7.0 | 295~470 | ≥180 | ≥30 |
| TA2G | 0.1~7.0 | ≥400 | ≥275 | ≥20 |
| TA3G | 0.1~7.0 | ≥500 | ≥380 | ≥18 |
| TA4G | 0.1~7.0 | ≥580 | ≥485 | ≥15 |
| TA8 | 0.1~7.0 | ≥345 | ≥275 | ≥20 |
| TA8-1 | 0.1~7.0 | ≥240 | ≥138 | ≥20 |
| TA9 | 0.1~7.0 | ≥345 | ≥275 | ≥18 |
| TA9-1 | 0.1~7.0 | ≥240 | ≥138 | ≥20 |

| Designation | Diameter/ mm | Tensile strength Rm/MPa | 0.2% proof strength (non-proportional extension) Rp0.2[a]/MPa | Percentage elongation after fracture A[b]/% |
|---|---|---|---|---|
| TA10 | 0.1~7.0 | ≥483 | ≥345 | ≥18 |
| TA18 | 0.1~7.0 | ≥620 | ≥483 | ≥15 |
| TC4ELI | 0.8~7.0 | ≥860 | ≥760 | ≥10 |
| TC4 | 0.8~<2.0 | ≥925 | ≥860 | ≥8 |
| | 2.0~7.0 | ≥895 | ≥828 | ≥10 |

NOTE: For wire for structural parts of other designations, the room-temperature tensile properties may be reported as measured values.

[a] The 0.2% proof strength (non-proportional extension) applies only to wire for structural parts with a diameter greater than 3.0 mm.

[b] When the percentage elongation after fracture of wire for structural parts with a diameter smaller than 3.0 mm does not meet the requirement, the measured value may be reported.

### 5.4 Macrostructure

Wire with a diameter of not less than 3.0 mm shall be subjected to macrostructure examination; on the transverse macrostructure there shall be no shrink cavity, porosity, delamination, or metallic or non-metallic inclusions.

### 5.5 Visual Quality

**5.5.1**

The wire shall be supplied with a pickled surface or a worked surface. When required by the purchaser and stated in the purchase order, straight wire with a diameter of not less than 2.0 mm may be supplied with a ground surface.

**5.5.2**

The surface of the wire shall be clean and free from oxide film, and shall be free from cracks, peeling, burrs, stains and inclusions.

## 6 Test Methods

### 6.1 Chemical Composition

The chemical composition analysis of the products shall be carried out in accordance with GB/T 4698 (all parts) or YS/T 1262; the arbitration analysis shall be carried out in accordance with GB/T 4698 (all parts).

### 6.2 Dimensions and Their Permissible Deviations

The dimensions and their permissible deviations of the products shall be measured in accordance with GB/T 38982.

### 6.3 Tensile Properties

The room-temperature tensile properties of the products shall be tested in accordance with GB/T 228.1. The original gauge length $L_0$ of the test piece shall conform to the following provisions:

——when the diameter is less than 4.0 mm, $L_0 = 50$ mm;

——when the diameter is not less than 4.0 mm, $L_0 = 4d_0$.

### 6.4 Macrostructure

The macrostructure examination of the products shall be carried out in accordance with GB/T 5168.

### 6.5 Visual Quality

The visual quality of the products shall be inspected by visual examination.

## 7 Inspection Rules

### 7.1 Inspection and Acceptance

**7.1.1**

The products shall be inspected by the supplier or a third party.

**7.1.2**

The purchaser may inspect the products received in accordance with the provisions of this document. When the inspection results do not conform to the provisions of this document or the purchase order, the matter shall be raised with the supplier in writing and settled through consultation between the supplier and the purchaser. Objections concerning the dimensions and their permissible deviations and the visual quality shall be raised within one month from the date of receipt of the products; objections concerning the chemical composition, tensile properties and macrostructure shall be raised within three months from the date of receipt of the products. If arbitration is required, samples shall be taken jointly by the supplier and the purchaser at the purchaser's premises or as agreed between the two parties.

### 7.2 Batching

The products shall be submitted for acceptance in lots. Each lot shall consist of wire of the same designation, the same melting furnace number, the same specification, the same manufacturing method, the same condition and from the same heat-treatment furnace batch.

### 7.3 Inspection Items

Each lot of products shall be inspected for chemical composition, dimensions and their permissible deviations, macrostructure and visual quality. Wire for structural parts shall additionally be subjected to the tensile property test.

## 7.4 Sampling

The sampling of the products shall conform to the requirements of Table 4.

**Table 4 — Sampling**

| Inspection item | Sampling provision | Clause for technical requirements | Clause for test method |
|---|---|---|---|
| Chemical composition[+] | 1 sample taken at random per lot | 5.1 | 6.1 |
| Dimensions and their permissible deviations | Every coil (spool, length) | 5.2 | 6.2 |
| Tensile properties | 2 coils (spools, lengths) taken at random per lot, 1 longitudinal test piece from each | 5.3 | 6.3 |
| Macrostructure | 2 coils (spools, lengths) taken at random per lot, 1 transverse test piece from each end; or 2 spools taken at random per lot, 1 transverse test piece from each | 5.4 | 6.4 |
| Visual quality | Every coil (spool, length) | 5.5 | 6.5 |

[+] The hydrogen content is sampled and analyzed on the finished product; for the other elements, the supplier reports the analysis results of the ingot, and re-verification by the purchaser is carried out on the finished product.

## 7.5 Judgement of Inspection Results

**7.5.1**

When the chemical composition inspection result is non-conforming, the whole lot shall be judged non-conforming.

**7.5.2**

When the inspection results of the dimensions and their permissible deviations or the visual quality are non-conforming, the individual coil (spool, length) of product shall be judged non-conforming. However, the supplier may remove the non-conforming portions, and the conforming products may be re-formed into lots for delivery.

**7.5.3**

In the tensile property test, when the inspection result of one test piece is non-conforming, double the number of test pieces shall be taken from the lot for repeat testing. When one test piece in the repeat test results is still non-conforming, the whole lot shall be judged non-conforming. However, the supplier may inspect coil by coil (spool by spool, length by length), and the conforming products may be re-formed into lots for delivery.

**7.5.4**

When the macrostructure inspection result is non-conforming, the whole lot shall be judged non-conforming.

# 8 Marking, Packaging, Transport, Storage and Accompanying Documents

## 8.1 Marking

### 8.1.1 Product Marking

A label or tag shall be attached to the products that have passed inspection, indicating at least the following contents:

a) name of the manufacturer and its trademark;

b) designation;

c) specification;

d) condition;

e) lot number;

f) number of this document.

### 8.1.2 Packaging Marking

The packaging marking of the products shall conform to the provisions of GB/T 8180.

## 8.2 Packaging, Transport and Storage

The packaging, transport and storage of the products shall conform to the provisions of GB/T 8180.

## 8.3 Accompanying Documents

Each lot of products shall be accompanied by the accompanying documents, which, in addition to the supplier information, product information, number of this document, and date of issue or date of packaging, shall preferably include:

a) a quality certificate, with the following contents:

——product name, designation, specification and condition;

——ingot number, lot number, lot weight and quantity of the product;

——main properties and technical parameters of the product;

——results of all analyses and inspections, and the seal of the quality inspection department;

——others.

b) a certificate of conformity, with the following contents:

——designation and specification;

——date of inspection;

——signature or seal of the inspector;

——others.

c) others.

## 9 Contents of the Purchase Order

According to its own needs, the purchaser may list the following contents in the purchase order for the products specified in this document:

a) product name;

b) designation;

c) specification;

d) condition;

e) quantity;

f) weight;

g) number of pieces;

h) number of this document;

i) others.