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

GB/T 45339-2025

**General technical specification for the titanium alloy parts by
hot isostatic pressing**

热等静压钛合金件通用技术规范

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1 Scope

This document specifies the technical requirements, test methods, inspection rules, marking, packing, transport, storage, accompanying documents and contents of the order for titanium alloy parts made by hot isostatic pressing.

This document applies to titanium alloy parts prepared from titanium alloy powder by the hot isostatic pressing process.

2 Normative references

The contents of the following documents constitute indispensable provisions of this document through normative reference in the text. For dated references, only the edition corresponding to that date applies to this document; for undated references, the latest edition, including all amendments, applies to this document.

GB/T 228.1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature.
GB/T 228.2 Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature. GB/T 229 Metallic materials - Charpy pendulum impact test method. GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method. GB/T 3500 Powder metallurgy - Vocabulary. GB/T 3620.1-2016 Designation and chemical composition of titanium and titanium alloys. GB/T 3850 Dense sintered metal materials and hardmetals - Determination of density. GB/T 4161 Metallic materials - Determination of plane-strain fracture toughness K_{IC}. GB/T 4698 (all parts) Methods for chemical analysis of titanium sponge, titanium and titanium alloys. GB/T 5193-2020 Titanium and titanium alloy processed products - Ultrasonic inspection method. GB/T 8180 Packing, marking, transport and storage of titanium and titanium alloy processed products. HB/Z 60 X-ray radiographic inspection.

3 Terms and definitions

The terms and definitions given in GB/T 3500 apply to this document.

4 Technical requirements

Chemical composition. The chemical composition of the product shall conform to Table 1, and other elements shall conform to 3.2 of GB/T 3620.1-2016. In Table 1 all figures are mass fractions in percent and titanium is the balance in every grade. For TA15 the main elements are aluminium 5.50 to 7.10, vanadium 0.8 to 2.5, molybdenum 0.5 to 2.0 and zirconium 1.5 to 2.5; the impurity elements, not greater than, are silicon 0.15, iron 0.25, carbon 0.08, nitrogen 0.05, hydrogen 0.015 and oxygen 0.15, with any single other element not greater than 0.10 and the total of other elements not greater than 0.30. For TC4 the main elements are aluminium 5.50 to 6.75 and vanadium 3.5 to 4.5, with no value given for molybdenum, zirconium or silicon; the impurity elements, not greater than, are iron 0.30, carbon 0.08, nitrogen 0.05, hydrogen 0.015 and oxygen 0.20, with any single other element not greater than 0.10 and the total not greater than 0.40. For TC4ELI the main elements are aluminium 5.50 to 6.50 and vanadium 3.5 to 4.5, with no value given for molybdenum, zirconium or silicon; the impurity elements, not greater than, are iron 0.25, carbon 0.08, nitrogen 0.03, hydrogen 0.012 and oxygen 0.13, with any single other element not greater than 0.10 and the total not greater than 0.30.

Tensile properties at room temperature. The tensile properties of the product at room temperature shall conform to Table 2, which gives minimum values. TA15: tensile strength R_m 930 MPa, proof strength at 0.2 percent plastic extension $R_{p0.2}$ 855 MPa, elongation after fracture A 10 percent, reduction of area Z 30 percent. TC4: 895 MPa, 825 MPa, 10 percent and 30 percent. TC4ELI: 840 MPa, 750 MPa, 13 percent and 35 percent.

Tensile properties at elevated temperature. The tensile properties of the product at elevated temperature shall conform to Table 3, which gives minimum values at a stated test temperature. TA15 tested at 500 degrees Celsius: tensile strength R_m 640 MPa, elongation after fracture A 12 percent, reduction of area Z 40 percent. TC4 tested at 400 degrees Celsius: 600 MPa, 12 percent and 40 percent. TC4ELI tested at 400 degrees Celsius: 480 MPa, 15 percent and 45 percent. Where the purchaser has a special requirement, it shall be agreed between supplier and purchaser and stated in the order.

Impact toughness. The impact toughness of the product shall conform to Table 4, which gives the minimum absorbed energy KU_2 : TA15 35 J, TC4 40 J, TC4ELI 40 J.

Fracture toughness. The fracture toughness of the product shall conform to Table 5, which gives the minimum K_{IC} expressed in MPa.m to the power one half: TA15 80, TC4 85, TC4ELI 85.

Hardness. The hardness of the product shall conform to Table 6, which gives the minimum

Brinell hardness HBW: TA15 290, TC4 290, TC4ELI 271.

Density. The density of the product shall conform to Table 7, which gives the minimum density in grams per cubic centimetre: TA15 4.43, TC4 4.42, TC4ELI 4.42.

Ultrasonic inspection. The ultrasonic inspection of the product shall conform to the requirements of class AA of GB/T 5193-2020.

Dimensions and permissible deviations. The dimensions and permissible deviations of the product shall conform to the technical drawing signed by supplier and purchaser; the requirements of the technical drawing may be reached by machining.

Appearance quality. The surface of the product shall be free from defects such as broken edges, broken corners, scratches and indentations.

Surface roughness. The surface roughness Ra of the product shall be not greater than 3.2 μm .

X-ray inspection. Where the purchaser requires X-ray inspection of the product, it shall be agreed between supplier and purchaser and stated in the order.

5 Test methods

Chemical composition. The analysis of the chemical composition of the product is carried out in accordance with GB/T 4698 (all parts).

Tensile properties at room temperature. The determination of the tensile properties of the product at room temperature is carried out in accordance with GB/T 228.1.

Tensile properties at elevated temperature. The determination of the tensile properties of the product at elevated temperature is carried out in accordance with GB/T 228.2.

Impact toughness. The determination of the impact toughness of the product is carried out in accordance with GB/T 229.

Fracture toughness. The determination of the fracture toughness of the product is carried out in accordance with GB/T 4161.

Hardness. The determination of the hardness of the product is carried out in accordance with GB/T 231.1.

Density. The determination of the density of the product is carried out in accordance with GB/T 3850.

Ultrasonic inspection. The ultrasonic inspection of the product is carried out in accordance with GB/T 5193-2020.

Dimensions and permissible deviations. The dimensions of the product are measured with measuring instruments of appropriate accuracy; the inspection positions and method are

agreed between supplier and purchaser.

Appearance quality. The appearance quality of the product is checked visually.

Surface roughness. The surface roughness of the product is inspected by comparison with roughness test blocks.

X-ray inspection. The X-ray inspection of the product is carried out in accordance with HB/Z 60.

6 Inspection rules

Inspection and acceptance. The product shall be inspected by the supplier or by a third-party testing body; the quality of the product shall conform to this document and to the order, and the accompanying documents shall be filled in.

The purchaser may inspect the product received in accordance with this document and the order. Where the inspection result does not agree with this document or with the order, the purchaser shall raise the matter with the supplier within 45 d of the date on which the product was received, and it shall be settled by agreement between supplier and purchaser. Where arbitration is needed, the arbitration sampling takes place at the purchaser and is carried out jointly by supplier and purchaser.

Batching. The product shall be submitted for acceptance in batches; each batch shall consist of product of the same raw material, the same melt, the same production process and the same grade.

Inspection items and sampling. The inspection items and sampling for the product shall conform to Table 8. Chemical composition, room-temperature tensile properties, elevated-temperature tensile properties, impact toughness, fracture toughness and hardness are sampled per melt or per product, with two test specimens taken, and are checked against 4.1 to 4.6 by the test methods of 5.1 to 5.6 respectively. Density, ultrasonic inspection, dimensions and permissible deviations, appearance quality and surface roughness are inspected piece by piece, and are checked against 4.7 to 4.11 by the test methods of 5.7 to 5.11 respectively.

Judgement of inspection results. Where the inspection result for the chemical composition, the room-temperature tensile properties, the elevated-temperature tensile properties, the impact toughness, the fracture toughness or the hardness of the product does not conform, a double quantity of specimens shall be taken from that batch and the non-conforming item retested; where the retest still gives a non-conforming result, the batch is judged non-conforming.

Where the inspection result for the density, the ultrasonic inspection, the dimensions and permissible deviations, the appearance quality or the surface roughness of the product does not conform, that piece is judged non-conforming.