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Titanium and titanium alloys — Bar, rod and billet — Technical delivery conditions

Titane et alliages de titane — Barre, tige et billette — Conditions techniques de livraison

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 11, *Titanium*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document was developed in response to worldwide demand for stabilizing the quality assurance for titanium and titanium alloys by common regulations worldwide.

Determining condition concerning the technical delivery conditions for bar, rod and billet of titanium and titanium alloys, such as chemical composition, mechanical properties and dimensional tolerance is extremely important to promote commerce of titanium and titanium alloys products in the global market.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning titanium alloys given in Table 1 and Table 2.

ISO takes no position concerning the evidence, validity and scope of this patent right.

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Titanium and titanium alloys — Bar, rod and billet — Technical delivery conditions

1 Scope

This document specifies requirements for the manufacture and technical delivery conditions of bar, rod and billet made from titanium and titanium alloys.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 377, *Steel and steel products — Location and preparation of samples and test pieces for mechanical testing*

ISO 6892-1:2019, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 10474:2013, *Steel and steel products — Inspection documents*

ISO 11484, *Steel products — Employer's qualification system for non-destructive testing (NDT) personnel*

ISO 28401, *Light metals and their alloys — Titanium and titanium alloys — Classification and terminology*

ASTM E8/E8M, *Standard Test Methods for Tension Testing of Metallic Materials*

ASTM E29, *Practice for Using Significant Digits in test Data to Determine Conformance with Specifications*

ASTM E539, *Standard Test Method for Analysis of Titanium Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry*

ASTM E1409, *Test method for determination of oxygen and nitrogen in titanium and titanium alloys by the inert gas fusion technique*

ASTM E1447, *Test method for determination of hydrogen in titanium and titanium alloys by the inert gas fusion thermal conductivity/ Infrared detection method*

ASTM E1941, *Standard Test method for determination of Carbon in Refractory and Reactive Metals and Their Alloys by Combustion Analysis*

ASTM E2371, *Standard Test method for Analysis of Titanium and Titanium alloys by Direct Current Plasma and Inductively Coupled Plasma Atomic Emission Spectrometry (Performance-Based Test Methodology)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 28401 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
bar
rod
solid wrought product of uniform cross-section equal to or under 10 000 mm^2 along its whole length, supplied in straight lengths

Note 1 to entry: The cross-section is in the shape of rounds, squares, rectangles or regular polygons like hexagons and octagons.

Note 2 to entry: Products with a square, rectangular or polygonal cross-section may have corners rounded along their whole length.

3.2
billet
solid wrought product of uniform cross-section above 10 000 mm^2 along its whole length, supplied in straight lengths

Note 1 to entry: The cross-section is in the shape of rounds, squares, rectangles or regular polygons like hexagons and octagons.

Note 2 to entry: Products with a square, rectangular or polygonal cross-section may have corners rounded along their whole length.

4 Information to be supplied by the purchaser

4.1 General information

The purchase order shall include the following information:

a) quantity (e.g. total mass or total length)

b) designation

c) dimensions

d) packaging

e) inspection

f) mill product certificate

g) certification (document issued and/or validated by an independent third party that assures that a product meets specified requirements such as a purchase order)

4.2 Options

A number of options are specified in this document and listed below. In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the bar, rod or billet shall be supplied in accordance with the basic specification.

a) restrictive chemistry (see 6.2)

b) product analysis (see 6.2)

c) special mechanical properties (see 6.3)

d) special tolerance (see 6.4)

e) method of manufacture and finish (see Clause 5 and 6.5)

5 Manufacturing

The bar, rod and billet shall be manufactured by hot-working such as hot-rolling, hot-forging, hot-extrusion of ingot or intermediate product followed by appropriate cold-working, if necessary, as well as surface conditioning and heat treatment. The bar, rod and billet shall be supplied as solid wrought product in straight shapes with uniform cross-section along their whole length.

6 Requirements

6.1 General

When supplied in the delivery condition indicated in 4.1 and inspected in accordance with Clause 7, the bar, rod and billet shall conform to the requirements of this document.

6.2 Chemical composition

The bar, rod and billet of titanium and titanium alloys shall conform to the chemical requirements prescribed in Table 1.

The elements listed in Table 1 are either intentional alloy additions or elements that are inherent to the manufacture of titanium sponge, ingot, or mill product.

The content of any element intentionally added to the formulation of the heat shall be reported.

Other elements are those not specified in the relevant designated material such as Cr and Mo of Ti1-0,18Pd and those not originally specified in the Table 1 such as Co and Hf. Generally, other elements include aluminium, vanadium, tin, molybdenum, chromium, manganese, zirconium, nickel, copper, silicon, cobalt, tungsten, hafnium and yttrium except for alloying elements contained in the designation. The element which is taken as the other element shall be subjected to the agreement between the manufacturer and the purchaser, and shall be noted in the purchase order.

Other elements should not be reported unless the content is greater than 0,1 % for each, or 0,4 % for total. The content of yttrium should not be reported unless the content is greater than 0,005 % for each.

When agreed upon between the manufacturer and the purchaser and specified in the purchase order, other specific residual elements not listed in Table 1 may be added and their content shall be reported.

The chemical analysis shall be conducted by the standard techniques normally used by the manufacturer and the purchaser. In case of disagreement, the test methods defined in ASTM E2371 or ASTM E539 shall be used as the referee method except for carbon, oxygen and hydrogen, which are not covered in these standards. Test methods defined in ISO 22960, ISO 22961 or ISO 22962 may be used as the referee method for iron instead of ASTM E2371 or ASTM E539. The test method defined in ASTM E1409 shall be used as a referee method for oxygen and nitrogen, and ISO 22963 may be used as a referee method for oxygen. The test method defined in ASTM E1447 shall be used as a referee method for hydrogen and the test method defined in ASTM E1941 shall be used as a referee method for carbon.

Table 1 — Chemical composition

Chemical composition in % mass fraction

Designation	C max	O max	N max	H max	Fe max	Al	V	Pd	Ru	Ni	Mo	Cr	Co	Sn	Other elements max	
															single	total
Ti1	0,08	0,18	0,03	0,015	0,20										0,1	0,4
Ti1H	0,08	0,18	0,03	0,015	0,20										0,1	0,4
Ti2L	0,08	0,20	0,03	0,015	0,25										0,1	0,4
Ti2	0,08	0,25	0,03	0,015	0,30										0,1	0,4
Ti3	0,08	0,35	0,05	0,015	0,30										0,1	0,4
Ti3H	0,08	0,35	0,05	0,015	0,30										0,1	0,4
Ti4	0,08	0,40	0,05	0,015	0,50										0,1	0,4
Ti1-0,18Pd	0,08	0,18	0,03	0,015	0,20			0,12-0,25							0,1	0,4
Ti1H-0,18Pd	0,08	0,18	0,03	0,013	0,20			0,12-0,25							0,1	0,4
Ti2L-0,18Pd	0,08	0,20	0,03	0,015	0,25			0,12-0,25							0,1	0,4
Ti2-0,18Pd	0,08	0,25	0,03	0,015	0,30			0,12-0,25							0,1	0,4
Ti3H-0,018Pd	0,08	0,35	0,05	0,015	0,30			0,12-0,25							0,1	0,4
Ti1-0,06Pd	0,08	0,18	0,03	0,015	0,20			0,04-0,08							0,1	0,4
Ti1H-0,06Pd	0,08	0,18	0,03	0,013	0,20			0,04-0,08							0,1	0,4
Ti2L-0,06Pd	0,08	0,20	0,03	0,015	0,25			0,04-0,08							0,1	0,4
Ti2-0,06Pd	0,08	0,25	0,03	0,015	0,30			0,04-0,08							0,1	0,4
Ti2-0,75Ni-0,3Mo	0,08	0,25	0,03	0,015	0,30					0,6-0,9	0,2-0,4				0,1	0,4
Ti1L-0,5Ni-0,05Ru	0,08	0,10	0,03	0,015	0,20				0,04-0,06	0,4-0,6					0,1	0,4

Table 1 *(continued)*

Designation	C max	O max	N max	H max	Fe max	Al	V	Pd	Ru	Ni	Mo	Cr	Co	Sn	Other elements max	
															single	total
Ti2L-0,5Ni-0,05Ru	0,08	0,15	0,03	0,015	0,30				0,04-0,06	0,4-0,6					0,1	0,4
Ti2-0,5Ni-0,05Ru	0,08	0,25	0,05	0,015	0,30				0,04-0,06	0,4-0,6					0,1	0,4
Ti2-0,5Co-0,06Pd	0,08	0,25	0,03	0,015	0,30			0,04-0,08					0,2-0,8		0,1	0,4
Ti3-0,5Co-0,06Pd	0,08	0,35	0,05	0,015	0,30			0,04-0,08					0,2-0,8		0,1	0,4
Ti2-0,45Ni-0,15Cr-0,03Ru-0,015Pd	0,08	0,25	0,03	0,015	0,30			0,01-0,02	0,02-0,04	0,35-0,55		0,1-0,2			0,1	0,4
Ti3-0,45Ni-0,15Cr-0,03Ru-0,015Pd	0,08	0,35	0,05	0,015	0,30			0,01-0,02	0,02-0,04	0,35-0,55		0,1-0,2			0,1	0,4
Ti-5Al-2,5Sn	0,08	0,20	0,03	0,015	0,50	4,0-6,0								2,0-3,0	0,1	0,4
Ti-1,5Al	0,08	0,25	0,03	0,015	0,30	1,0-2,0									0,1	0,4
Ti-3Al-2,5V	0,08	0,15	0,03	0,015	0,25	2,5-3,5	2,0-3,0								0,1	0,4
Ti-6Al-4V	0,08	0,20	0,05	0,015	0,40	5,5-6,75	3,5-4,5								0,1	0,4
Ti-6Al-4V ELI	0,08	0,13	0,03	0,012 5	0,25	5,5-6,5	3,5-4,5								0,1	0,4
Ti-22V-4Al	0,10	0,25	0,05	0,015	1,00	3,50-4,50	20,0-23,0								0,1	0,4
Ti-6Al-1Fe	0,10	0,30	0,05	0,015	0,4-1,5	5,5-6,5									0,1	0,4