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Light metals and their alloys — Titanium and titanium alloys — Classification and terminology

Métaux légers et leurs alliages — Titane et alliages de titane — Classification et terminologie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 28401 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 11, *Titanium*.

Light metals and their alloys — Titanium and titanium alloys — Classification and terminology

1 Scope

This International Standard gives a classification of titanium and titanium alloys. It also gives terms and definitions in the field of titanium and its alloys.

2 Material

2.1
titanium sponge
products of metallic titanium in porous and sponge-like form, which is applied as titanium metal melting stock

NOTE The oxidized titanium ore is first chlorinated to tetrachloride and is condensed and purified and then reduced with magnesium or sodium under the inert atmosphere to produce titanium sponge.

2.2
alloy
metallic substance consisting of a mixture of the basic metallic element (the element predomination by mass) and other elements, such as alloying elements and impurities

2.3
alloying element
metallic or non-metallic elements intentionally added to, or retained by, basic metal for the purpose of giving that metal certain special properties

2.4
impurity
metallic or non-metallic elements present but which are not intentionally added to, or retained by, a metal

2.5
wrought alloy
alloy primarily intended for the production of wrought products by hot and/or cold plastic forming

2.6
casting alloy
alloy primarily intended for the production of castings

2.7
master alloy
alloy intended only for addition to a melt to adjust composition or to control impurities

2.8
heat-treatable alloy
alloy capable of being strengthened by a suitable thermal treatment

2.9
non-heat-treatable alloy
alloy strengthened by cold working only and incapable of being substantially strengthened by thermal treatment

3 Specific terms and definitions

3.1
intermediate-strength alloys
alloys with improved properties due to a limited percentage of alloying elements enhancing mechanical resistance and, from case to case, also corrosion resistance

3.2
high-strength standard alloys
alloys with properties similar to the alloy work-horse Ti-6Al-4V (Al ≈ 6 %, V ≈ 4 %), well defined and used with experience

3.3
special alloy grades
high-strength and highly alloyed grades for special use, for example, in military and space equipment

4 Unwrought products

4.1
unwrought product
general term for products obtained by melting or casting processes

EXAMPLES Ingots for rolling, ingots for extruding, ingots for forging and ingots for remelting.

4.2
electrode for remelting
formed from titanium sponge and alloying elements or consolidated from recycled and processed scrap, normally to be remelted finally at least once under a vacuum or in argon

4.3
ingot for rolling
titanium ingot in a form suitable for rolling, melted by EB, VAR, VASM or PM methods applied for at least the final cycle under a vacuum or in argon

4.4
ingot for extruding
titanium ingot in a form suitable for extrusion of bars, tubes and slaps melted by EB, VAR, VASM or PM methods applied for at least the final cycle under a vacuum or in argon

4.5
ingot for forging
titanium ingot in a form suitable for forging, melted by EB, VAR, VASM or PM methods applied for at least the final cycle under a vacuum or in argon

4.6
ingot for remelting
titanium ingot in a form suitable for remelting after having been processed metallurgically for composition, melted by EB, VAR, VASM or PM methods applied for at least the final cycle under a vacuum or in argon

5 Wrought products

5.1
wrought product
general term for products obtained by hot and/or cold plastic deformation processes, such as extruding, forging, hot rolling, cold rolling or drawing, either solely or in combination

EXAMPLES Rod/bar, billets, wire, tube, shape/profile, sheet, plate, strip, foils, die forgings, open die forgings.

NOTE For the classification principles of wrought products, see Annex B.

5.2
billets
solid wrought product of uniform cross-section that is above 10 000 mm^2 along its whole length, supplied in straight lengths

NOTE The cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons. Products with a square, rectangular, triangular or polygonal cross-section may have corners rounded along their whole length.

5.3
rod/bar
solid wrought product of uniform cross-section that is under 10 000 mm^2 along its whole length, supplied in straight lengths

NOTE 1 The cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons. Products with a square, rectangular, triangular or polygonal cross-section may have corners rounded along their whole length.

NOTE 2 For rectangular bars:

— the thickness exceeds one-third of the width;

— the term “rectangular bar” includes “flattened circles” and “modified rectangles”, of which two opposite sides are convex arcs, the other two sides being straight, of equal length and parallel.

5.4
wire
solid wrought product of uniform cross-section along its whole length, supplied in coiled form

NOTE 1 The cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons. Products with a square, rectangular, triangular or polygonal cross-section may have corners rounded along their whole length.

NOTE 2 For rectangular wires:

— the thickness exceeds one-third of the width;

— the term “rectangular wire” includes “flattened circles” and “modified rectangles”, of which two opposite sides are convex arcs, the other two sides being straight, of equal length and parallel.

5.5
drawing stock
intermediate solid wrought product of uniform cross-section along its whole length supplied in coils

NOTE The cross-sections are approximately round, triangular or regular polygonal with dimensions usually exceeding 5 mm.

5.6
tube
hollow wrought product of uniform cross-section with only one enclosed hollow space along its whole length, and with a uniform wall thickness, supplied in straight lengths or in coiled form

NOTE 1 The cross-sections are in the shape of circles, ovals, squares, rectangles, equilateral triangles or regular polygons. Hollow products with square, rectangular, equilateral triangular or regular polygonal cross-sections, which may have corners rounded along their whole length, are also to be considered as tubes, provided the inner and outer peripheries are concentric and have the same form and orientation.

NOTE 2 Tubes can also be formed by piercing trespassing and by forming and joining sheet or strip.

NOTE 3 Bent, threaded, drilled, waisted, expanded and cone-shaped hollow products in this form, when derived from tubes as defined above, are classified as tubes.

5.7
profile/shape
wrought product of uniform cross-section along its whole length, with a cross-section other than rod/bar, wire, tube, sheet, plate or strip, supplied in straight lengths or in coiled form

NOTE According to the form of its cross-section, it is called hollow profile or non-hollow profile.

a) Hollow profile

The cross-section includes:

— either one enclosed hollow space, provided that the cross-section is for other than a tube, or

— more than one enclosed hollow space.

b) Non-hollow profile

The cross-section does not include any enclosed hollow space.

5.8
plate
flat-rolled product of rectangular cross-section with uniform thickness over 5 mm, supplied in straight lengths (i.e. flat) usually with sheared, sawn or flame-cut/plasma-cut edges or water-jet cutting

NOTE The thickness does not exceed one-tenth of the width.

5.9
sheet
flat-rolled product of rectangular cross-section with uniform thickness over 0,20 mm and up to and including 5 mm, supplied in straight lengths (i.e. flat) usually with sheared or sawn edges or water jet cutting

NOTE The thickness does not exceed one-tenth of the width.

5.10
strip
flat-rolled product of rectangular cross-section with uniform thickness over 0,20 mm, supplied in coils usually with slit edges

NOTE 1 The thickness does not exceed one-tenth of the width.

NOTE 2 Corrugated, embossed (with patterns, for example, grooves, ribs, checkers, tears, buttons, lozenges), coated, edge conditioned and perforated products in this general form when derived from strip as defined above are classified as strip.

NOTE 3 In some English-speaking countries, “strip” is called “coiled sheet”.

5.11
foil
flat-rolled product of rectangular cross-section with uniform thickness equal to or less than 0,20 mm

NOTE In some countries, the term “foil” covers two different products:

— foil: products with lesser thickness;

— thin strip: products with greater thickness.

The dimensional limitations between these two products may vary from country to country.

5.12
forging stock
hot-worked intermediate solid wrought product, for example rod/bar or billets, or any other cross-section, suitable for forging

NOTE Forging stock may also be a cast product, for example, ingot for forging (see 4.5).

5.13
casting stock
cast or hot-worked intermediate solid wrought product, for example, rod/bar or billets, or any other cross-section, suitable for casting

5.14
forging
wrought product formed by hammering or pressing, usually when hot, between open dies (hand forging) or closed dies (drop or die forging)

5.15
blank
piece of titanium of regular or irregular shape taken from a flat wrought product intended for subsequent processing, such as bending, stamping or deep drawing

5.16
circle
circular blank

6 Castings

6.1
casting
general term for products at or near the finished shape, formed by solidification of titanium or titanium alloys in a mould

6.2
sand/graphite casting
rammed graphite moulding
casting formed in a sand/graphite mould

6.3
permanent mould casting
chill casting
casting formed in a metal mould, the molten metal being introduced by gravity or low-pressure feed

6.4
pressure die casting
die casting
casting formed in a metal mould, the molten metal being introduced under high pressure

6.5
centrifugal casting
casting formed by centrifugal force in a rotating mould, the major axis of the casting coinciding with the axis of rotation, and the thickness of the casting being determined by the dimensions of the mould and quantity of titanium poured

NOTE Centrifugal casting is not to be confused with casting under centrifugal pressure.

6.6
investment casting
casting method using ceramic shells inert to molten titanium

NOTE The wax pattern has to be removed before pouring the liquid metal into the mould.