INTERNATIONAL STANDARD

ISO 24034

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Welding consumables — Solid wire electrodes, solid wires and rods for fusion welding of titanium and titanium alloys — Classification

Produits consommables pour le soudage — Fils-électrodes pleins, fils pleins et baguettes pleines pour le soudage par fusion du titane et des alliages de titane — Classification

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 24034 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 3, *Welding consumables*.

This second edition cancels and replaces the first edition (ISO 24034:2005), which has been technically revised.

Requests for official interpretations of any aspect of this International Standard should be directed to the Secretariat of ISO/TC 44/SC 3 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Introduction

This International Standard proposes a classification in order to designate solid wire electrodes, solid wires and rods in terms of their chemical composition.

There is no unique relationship between the product form (solid wire electrodes, solid wires or rods) and the welding process used (gas-shielded metal arc welding, tungsten inert gas arc welding, plasma arc welding or laser beam welding). For this reason, solid wire electrodes, solid wires and rods may be classified in terms of their chemical composition.

In this International Standard, the symbol of the welding process is not used, because

a) different joining processes are performed with the same chemical component consumable;

b) the producer is not able to determine the process symbol before shipping.

Also, it should be noted that the mechanical properties of all-weld metal test specimens or welded joints produced by welding consumables will vary from those obtained in production joints because of differences in welding procedure and the base-metal alloy. For this reason, the mechanical properties of all-weld metal or welded joints for titanium-welding consumables are not specified in this classification.

Welding consumables — Solid wire electrodes, solid wires and rods for fusion welding of titanium and titanium alloys — Classification

1 Scope

This International Standard specifies requirements for the classification of solid wire electrodes, solid wires and rods for fusion welding of titanium and titanium alloys. The classification is based on their chemical composition.

The compositions of solid wire electrodes for metal inert gas (MIG) welding are the same as solid wire electrodes, solid wires and rods for tungsten inert gas (TIG) arc welding, plasma arc welding, laser beam welding, and other fusion welding processes.

2 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.

ISO 544, *Welding consumables — Technical delivery conditions for filler materials and fluxes — Type of product, dimensions, tolerances and markings*

ISO 14344, Welding consumables — Procurement of filler materials and fluxes

ISO 80000-1:2009, *Quantities and units — Part 1:General*

3 Classification

The classification is divided into two parts:

a) the first part gives a symbol indicating the product to be identified, see 4.1;

b) the second part gives a symbol indicating the chemical composition of the solid wire electrodes, solid wires and rods, see Table 1.

4 Symbols and requirements

4.1 Symbol for the product

The symbol for the solid wire electrodes, solid wires and rods shall be S.

4.2 Symbol for the chemical composition

The numerical symbols in Table 1 indicate the chemical composition of a solid wire or rod, determined under the conditions given in Clause 6. The first two digits indicate the alloy group. See Annex A for an explanation of the numerical symbols.

The optional additional chemical symbols in Table 1 indicate the chemical composition and include an indication of the characteristic alloying elements.

5 Mechanical properties

Mechanical properties of all-weld metal or welded joints are not part of this classification.

6 Chemical analysis

Chemical analysis shall be performed on specimens of the product or the stock from which it is made. See also footnote c to Table 1. Any analytical technique may be used but, in cases of dispute, reference shall be made to established published methods, agreed between the contracting parties.

7 Rounding procedure

For purposes of determining compliance with the requirements of this International Standard, the actual test values obtained shall be subjected to the rounding rules of ISO 80000-1:2009, Annex B, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this International Standard, the measured values shall be converted to the units of this International Standard before rounding. If an average value is to be compared to the requirements of this International Standard, rounding shall be done only after calculating the average. In the case where the testing standard cited in the normative references of this International Standard contains instructions for rounding that conflict with the instructions of this International Standard, the rounding requirements of the testing standard shall apply. The rounded-off results shall fulfil the requirements of the appropriate table for the classification under test.

8 Retest

If any test fails to meet the requirement, that test shall be repeated twice. The results of both retests shall meet the requirement. Specimens for the retest may be taken from the original test sample or from a new test sample. For chemical analysis, retests need be only for those specific elements that failed to meet their test requirement. If the results of one or both retests fail to meet the requirement, the material under test shall be considered as not meeting the requirements of this specification for that classification.

In the event that, during preparation or after completion of any test, it is clearly determined that prescribed or proper procedures were not followed in preparing the weld test sample or test specimen(s), or in conducting the tests, the test shall be considered invalid, without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirement. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

9 Technical delivery conditions

Technical delivery conditions shall meet the requirements of ISO 544 and ISO 14344.

Table 1 — Chemical composition requirements

Alloy symbols		Chemical composition, % (by mass) [a, b, c, d]										
numerical	**chemical**	**C**	**O**	**N**	**H**	**Fe**	**Al**	**V**	**Sn**	**Pd**	**Ru**	**Other**
Ti 0100	Ti99,8	0,03	0,03 to 0,10	0,012	0,005	0,08	—	—	—	—	—	—
Ti 0120	Ti99,6	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	—	—	—
Ti 0125	Ti99,5	0,03	0,13 to 0,20	0,02	0,008	0,16	—	—	—	—	—	—
Ti 0130	Ti99,3	0,03	0,18 to 0,32	0,025	0,008	0,25	—	—	—	—	—	—
Ti 2251	TiPd0,2	0,03	0,03 to 0,10	0,012	0,005	0,08	—	—	—	0,12 to 0,25	—	—
Ti 2253	TiPd0,06	0,03	0,03 to 0,10	0,012	0,005	0,08	—	—	—	0,04 to 0,08	—	—
Ti 2255	TiRu0,1	0,03	0,03 to 0,10	0,012	0,005	0,08	—	—	—	—	0,08 to 0,14	—
Ti 2401	TiPd0,2A	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	0,12 to 0,25	—	—
Ti 2403	TiPd0,06A	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	0,04 to 0,08	—	—
Ti 2405	TiRu0,1A	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	—	0,08 to 0,14	—
Ti 3401	TiNi0,7Mo0,3	0,03	0,08 to 0,16	0,015	0,008	0,15	—	—	—	—	—	Mo: 0,2 to 0,4 Ni: 0,6 to 0,9
Ti 3416	TiRu0,05Ni0,5	0,03	0,13 to 0,20	0,02	0,008	0,16	—	—	—	—	0,04 to 0,06	Ni: 0,4 to 0,6
Ti 3423	TiNi0,5	0,03	0,03 to 0,10	0,012	0,005	0,08	—	—	—	—	0,04 to 0,06	Ni: 0,4 to 0,6
Ti 3424	TiNi0,5A	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	—	0,04 to 0,06	Ni: 0,4 to 0,6
Ti 3443	TiNi0,45Cr0,15	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	0,01 to 0,02	0,02 to 0,04	Cr: 0,1 to 0,2 Ni: 0,35 to 0,55
Ti 3444	TiNi0,45Cr0,15A	0,03	0,13 to 0,20	0,02	0,008	0,16	—	—	—	0,01 to 0,02	0,02 to 0,04	Cr: 0,1 to 0,2 Ni: 0,35 to 0,55
Ti 3531	TiCo0,5	0,03	0,08 to 0,16	0,015	0,008	0,12	—	—	—	0,04 to 0,08	—	Co: 0,20 to 0,80
Ti 3533	TiCo0,5A	0,03	0,13 to 0,20	0,02	0,008	0,16	—	—	—	0,04 to 0,08	—	Co: 0,20 to 0,80
Ti 4251	TiAl4V2Fe	0,05	0,20 to 0,27	0,02	0,010	1,2 to 1,8	3,5 to 4,5	2,0 to 3,0	—	—	—	—
Ti 4621	TiAl6Zr4Mo2Sn2	0,04	0,30	0,015	0,015	0,05	5,50 to 6,50	—	1,80 to 2,20	—	—	Zr: 3,60 to 4,40 Mo: 1,80 to 2,20 Cr: 0,25 max
Ti 5112	TiAl5V1Sn1Mo1Zr1	0,03	0,05 to 0,10	0,012	0,008	0,20	4,5 to 5,5	0,6 to 1,4	0,6 to 1,4	—	—	Mo: 0,6 to 1,2 Zr: 0,6 to 1,4 Si: 0,06 to 0,14

Table 1 (*continued*)

Alloy symbols		Chemical composition, % (by mass) [a, b, c, d]										
numerical	chemical	C	O	N	H	Fe	Al	V	Sn	Pd	Ru	Other
Ti 6321	TiAl3V2,5A	0,03	0,06 to 0,12	0,012	0,005	0,20	2,5 to 3,5	2,0 to 3,0	—	—	—	—
Ti 6324	TiAl3V2,5Ru	0,03	0,06 to 0,12	0,012	0,005	0,20	2,5 to 3,5	2,0 to 3,0	—	—	0,08 to 0,14	—
Ti 6326	TiAl3V2,5Pd	0,03	0,06 to 0,12	0,012	0,005	0,20	2,5 to 3,5	2,0 to 3,0	—	0,04 to 0,08	—	—
Ti 6402	TiAl6V4B	0,05	0,12 to 0,20	0,030	0,015	0,22	5,50 to 6,75	3,50 to 4,50	—	—	—	—
Ti 6408	TiAl6V4A	0,03	0,03 to 0,11	0,012	0,005	0,20	5,5 to 6,5	3,5 to 4,5	—	—	—	—
Ti 6413	TiAl6V4Ni0,5Pd	0,05	0,12 to 0,20	0,030	0,015	0,22	5,5 to 6,7	3,5 to 4,5	—	0,04 to 0,08	—	Ni: 0,3 to 0,8
Ti 6414	TiAl6V4Ru	0,03	0,03 to 0,11	0,012	0,005	0,20	5,5 to 6,5	3,5 to 4,5	—	0,08 to 0,14	—	—
Ti 6415	TiAl6V4Pd	0,05	0,12 to 0,20	0,030	0,015	0,22	5,5 to 6,7	3,5 to 4,5	—	—	—	Pd: 0,04 to 0,08
Ti 8211	TiMo15Al3Nb3	0,03	0,10 to 0,15	0,012	0,005	0,20 to 0,40	2,5 to 3,5	—	—	—	—	Mo14,0 to 16,0 Nb 2,2 to 3,2 Si 0,15 to 0,25
Ti 8451	TiNb45	0,03	0,06 to 0,12	0,02	0,0035	0,03	—	—	—	—	—	Nb 42,0 to 47,0
Ti 8641	TiV8Cr6Mo4Zr4Al3	0,03	0,06 to 0,10	0,015	0,015	0,20	3,0 to 4,0	7,5 to 8,5	—	—	—	Mo 3,5 to 4,5 Cr 5,5 to 6,5 Zr3,5 to 4,5
Ti 8646	TiV8Cr6Mo4Zr4Al3Pd	0,03	0,06 to 0,10	0,015	0,015	0,20	3,0 to 4,0	7,5 to 8,5	—	0,04 to 0,08	—	Mo 3,5 to 4,5 Cr 5,5 to 6,5 Zr 3,5 to 4,5
	ZTi [e]	Any other agreed composition										

NOTE Corresponding national classifications are shown in Annex B.

[a] Single values are maxima, unless otherwise noted.

[b] The remainder of the alloy is titanium.

[c] Analysis of the interstitial elements C, O, H and N shall be conducted on samples of rod/wire taken after the rod/wire has been reduced to its final diameter and all processing operations have been completed. Analysis of the other elements may be conducted on the same samples, or it may have been conducted on samples taken from the ingot or the rod stock from which the rod/wire is made. In cases of dispute, samples from the finished rod/wire shall be the referee method.

[d] Total residual elements shall not exceed 0,20 % (by mass), with no single such element exceeding 0,05 %, except for yttrium, which shall not exceed 0,005 %. Residual elements need not be reported unless a report is specifically required by the purchaser. Residual elements are those elements other than titanium that are not listed in this table for the particular classification, but which are inherent in the raw material or the manufacturing practice. Residual elements may be present only in trace amounts and they may not be elements that have been intentionally added to the product.

[e] Consumables for which the chemical composition is not listed in this table shall be symbolized similarly and prefixed by the letter Z. The chemical composition ranges are not specified and it is possible that two electrodes with the same Z-classification are not interchangeable.

10 Designation

The designation of solid wire electrodes, solid wires and rods shall follow the principles given in the examples below.

EXAMPLE 1 A solid wire (S) for fusion welding that has a chemical composition within the limits for the alloy symbol Ti 6402 (TiAl6V4B) of Table 1 is designated as follows:

Solid wire ISO 24034 – S Ti 6402

or alternatively:

Solid wire ISO 24034 – S Ti 6402 (TiAl6V4B)

EXAMPLE 2 A solid rod (S) for fusion welding is designated as follows:

Solid rod ISO 24034 – S Ti 6402

or alternatively:

Solid rod ISO 24034 – S Ti 6402 (TiAl6V4B)

where, for the two examples

ISO 24034 is the number of this International Standard;

S is the product form (see 4.1);

Ti 6402 is the chemical composition of welding consumable (see Table 1);

TiAl6V4B is the optional chemical symbol for chemical composition Ti 6402 (see Table 1).