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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*

ICS: 25.160.20

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ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Fax: +41 22 749 09 47  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

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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.

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](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://www.iso.org/iso/foreword.html).

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

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](http://www.iso.org/members.html).

Official interpretations of TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

This third edition cancels and replaces the second edition (ISO 24034:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

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## Introduction

This document 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 document, 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.

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

## 1 Scope

This document 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 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 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 Terms and definitions

No terms and definitions are listed in this document.

*The list below is always included after each option:*

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

## 4 Classification

The classification is divided into two parts:

- a) the first part gives a symbol indicating the product to be identified, see [5.1](#);
- b) the second part gives a symbol indicating the chemical composition of the solid wire electrodes, solid wires and rods, see [Table 1](#).

## 5 Symbols and requirements

### 5.1 Symbol for the product

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

### 5.2 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 7](#). 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.

## 6 Mechanical properties

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

## 7 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.

## 8 Rounding procedure

Actual test values obtained shall be subject to ISO 80000-1:2009, B.3, Rule A. If the measured values are obtained by equipment calibrated in units other than those of this document, the measured values shall be converted to the units of this document before rounding. If an average value is to be compared to the requirements of this document, rounding shall be done only after calculating the average. The rounded results shall fulfil the requirements of the appropriate table for the classification under test.

## 9 Retests

If any test fails to meet the requirement(s), 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 assembly or sample or from one or two new test assemblies. For chemical analysis, retests need only be for those specific elements that failed to meet the 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 document 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 assembly or sample(s) or test specimen(s), or in conducting the tests, the test shall be considered invalid. This determination is made without regard to whether the test was actually completed, or whether the test results met, or failed to meet, the requirements. That test shall be repeated, following proper prescribed procedures. In this case, the requirement for doubling the number of test specimens does not apply.

## 10 Technical delivery conditions

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



Table 1 — Chemical composition requirements

Alloy symbols numerical	chemical	Chemical composition, % (by mass) a, b, c, d											Other				
		C	O	N	H	Fe	Al	V	Sn	Pd	Ru						
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