

Titanium Welding Wire
Commercially Pure
Environment Controlled Packaging
(Composition similar to UNS R50550)

1. SCOPE:

1.1 Form:

This specification covers one grade of commercially pure titanium in the form of welding wire.

1.2 Application:

This wire has been used typically as filler metal for gas-metal-arc and gas-tungsten-arc welding, but usage is not limited to such applications.

1.3 Classification:

Product covered by this specification is classified by melting practice as follows:

Type I - Multiple melted with at least one of the melting cycles under vacuum.

Type II - Electron beam melted.

1.3.1 Unless a specific type is ordered, either type may be supplied.

2. APPLICABLE DOCUMENTS:

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

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<http://www.sae.org>

SAE WEB ADDRESS:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

- AMS 2249 Chemical Check Analysis Limits, Titanium and Titanium Alloys
 AMS 2814 Packaging and Marking of Packages of Welding Wire, Premium Quality
 AMS 2816 Identification, Welding Wire, Tab Marking Method
 AMS 2819 Identification, Welding Wire, Direct Color Code System
- ARP1876 Weldability Test for Weld Filler Metal Wire
 ARP4926 Alloy Verification and Chemical Composition Inspection of Welding Wire

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.sae.org.

- ASTM E 8 Tension Testing of Metallic Materials
 ASTM E 8M Tension Testing of Metallic Materials (Metric)
 ASTM E 120 Chemical Analysis of Titanium and Titanium Alloys
 ASTM E 1409 Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique
 ASTM E 1447 Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

3. TECHNICAL REQUIREMENTS:

3.1 Wire Composition:

Shall conform to the percentages by weight shown in Table 1; oxygen shall be determined in accordance with ASTM E 1409, hydrogen in accordance with ASTM E 1447, and other elements by wet chemical methods in accordance with ASTM E 120, by spectrochemical methods, or by other analytical methods acceptable to purchaser.

TABLE 1 - Composition

| Element | min | max |
|------------------------------------|-----------|----------------|
| Iron | -- | 0.20 |
| Oxygen (3.1.1.1) | -- | 0.18 |
| Carbon (3.1.1.1) | -- | 0.08 |
| Nitrogen (3.1.1.1) | -- | 0.05 |
| Hydrogen (3.1.1.1) | -- | 0.005 (50 ppm) |
| Residual Elements, each (3.1.1.2) | -- | 0.10 |
| Residual Elements, total (3.1.1.2) | -- | 0.40 |
| Titanium | remainder | |

- 3.1.1 Except for carbon, oxygen, nitrogen, and hydrogen, chemical analysis of initial ingot, bar, or rod stock before drawing is acceptable provided the processes used for drawing or rolling, annealing, and cleaning are controlled to ensure continued conformance to composition requirements.
- 3.1.1.1 Carbon, oxygen, nitrogen, and hydrogen shall also be determined on each lot of finished wire.
- 3.1.1.2 Determination not required for routine acceptance.
- 3.1.2 Check Analysis: Composition variations shall meet the applicable requirements of AMS 2249.
- 3.1.3 Sample size when using ASTM E 1447 for hydrogen may be as large as 0.35 gram.
- 3.2 Melting Practice:
- Alloy shall be electron beam melted or shall be multiple melted with at least one of the melting cycles under vacuum. When multiple melted, the first melt shall be by consumable electrode, nonconsumable electrode, electron beam, or plasma arc melting practice. The subsequent melt or melts shall be made using vacuum consumable electrode practice with no alloy additions permitted in the last consumable electrode melt.
- 3.2.1 The atmosphere for nonconsumable electrode melting shall be vacuum or shall be inert gas at a pressure not higher than 1000 mm of mercury.
- 3.2.2 The electrode tip for nonconsumable electrode melting shall be water-cooled copper.
- 3.3 Condition:
- As drawn, having tensile strength not higher than 130 ksi (896 MPa), determined in accordance with ASTM E 8 or ASTM E 8M, and descaled.
- 3.4 Fabrication:
- 3.4.1 Wire shall be formed from rod or bar descaled by a process which does not affect the composition of the wire. Surface irregularities inherent with a forming process that does not tear the wire surface are acceptable provided the wire conforms to the tolerances of 3.7.
- 3.4.2 In-process annealing, if required between cold rolling or drawing operations, shall be performed in a vacuum or in protective atmosphere to avoid surface oxidation and adsorption of other extraneous elements.
- 3.4.3 Butt welding is permissible provided both ends to be joined are either alloy verified using a method or methods capable of distinguishing the alloy from all other alloys processed within the facility, or the repair is made at the wire processing station. The butt weld shall not interfere with the uniform, uninterrupted feeding of the wire in machine welding equipment.

3.4.4 Drawing compounds, oxides, dirt, oil, and other foreign materials shall be removed by cleaning processes which will neither result in pitting nor cause gas absorption by the wire or deposition of substances harmful to welding operations.

3.4.5 Residual elements and dissolved gasses picked up during wire processing that can adversely affect the welding characteristics, the operation of the equipment, or the properties of the weld metal, shall be removed.

3.5 Properties:

Wire shall conform to the following requirements:

3.5.1 Weldability: Melted wire shall flow smoothly and evenly during welding and shall produce acceptable welds. ARP1876 may be used to resolve disputes.

3.5.2 Spooled Wire: Shall conform to 3.5.2.1 and 3.5.2.2.

3.5.2.1 Cast: Wire, wound on standard 12-inch (305-mm) diameter spools, shall have imparted to it a curvature such that a specimen sufficient in length to form a loop, with a 1-inch (25 mm) overlap, when cut from the spool and laid on a flat surface, shall form a circle 15 to 50 inches (381 to 1270 mm) in diameter.

3.5.2.2 Helix: The specimen on which cast was determined, when laid on a flat surface and measured between adjacent turns, shall show a vertical separation not greater than 1 inch (25 mm).

3.6 Quality:

Wire, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from imperfections detrimental to welding operations, operation of welding equipment, or properties of the deposited weld metal.

3.7 Sizes and Tolerances:

Wire shall be supplied in the sizes and to the tolerances shown in 3.7.1 and 3.7.2.

3.7.1 Diameter: Shall be as shown in Table 2.

TABLE 2A - Sizes and Diameter Tolerances, Inch/Pound Units

| Form | Nominal Diameter Inch | Tolerance, Inch | |
|-------------|----------------------------|-----------------|--------|
| | | Plus | Minus |
| Cut Lengths | 0.030, 0.045, 0.062, 0.078 | 0.002 | 0.002 |
| Cut Lengths | 0.094, 0.125, 0.156, 0.188 | 0.003 | 0.003 |
| Spools | 0.007, 0.010, 0.015 | 0.0005 | 0.0005 |
| Spools | 0.020, 0.030, 0.035, 0.045 | 0.001 | 0.002 |
| Spools | 0.062, 0.078, 0.094 | 0.002 | 0.002 |

TABLE 2B - Sizes and Diameter Tolerances, SI Units

| Form | Nominal Diameter Millimeters | Tolerance, Millimeter | |
|-------------|---------------------------------|-----------------------|-------|
| | | Plus | Minus |
| Cut Lengths | 0.76, 1.14, 1.57, 1.98 | 0.05 | 0.05 |
| Cut Lengths | 2.39, 3.18, 3.96, 4.78 | 0.08 | 0.08 |
| Spools | 0.18, 0.25, 0.38 | 0.013 | 0.013 |
| Spools | 0.051, 0.76, 0.89, 1.14 | 0.03 | 0.05 |
| Spools | 1.57, 1.98, 2.39 | 0.05 | 0.05 |

3.7.2 Length: Cut lengths shall be furnished in 12, 18, 27, or 36 inch (305, 457, 686, or 914 mm) lengths, as ordered, and shall not vary more than +0, -0.5 inch (-13 mm) from the length ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The vendor of wire shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the wire conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Composition (3.1), condition (3.3), tolerances (3.7), and alloy verification (5.2) are acceptance tests and shall be performed on each heat or lot as applicable.

4.2.2 Periodic Tests: Weldability (3.5.1), cast (3.5.2.1), and helix (3.5.2.2) are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.