Designation: B 863 – 06

Standard Specification for Titanium and Titanium Alloy Wire[1]

This standard is issued under the fixed designation B 863; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers titanium and titanium alloy wire as follows:

1.1.1 *Grade 1*—Unalloyed titanium, low oxygen,

1.1.2 *Grade 2*—Unalloyed titanium, standard oxygen,

1.1.3 *Grade 3*—Unalloyed titanium, medium oxygen,

1.1.4 *Grade 4*—Unalloyed titanium, high oxygen,

1.1.5 *Grade 5*—Titanium alloy (6 % aluminum, 4 % vanadium),

1.1.6 *Grade 6*—Titanium alloy (5 % aluminum, 2.5 % tin),

1.1.7 *Grade 7*—Unalloyed titanium plus 0.12 % to 0.25 % palladium, standard oxygen,

1.1.8 *Grade 9*—Titanium alloy (3 % aluminum, 2.5 % vanadium),

1.1.9 *Grade 11*—Unalloyed titanium plus 0.12 % to 0.25 % palladium, low oxygen,

1.1.10 *Grade 12*—Titanium alloy (0.3 % molybdenum, 0.8 % nickel),

1.1.11 *Grade 13*—Titanium alloy (0.5 % nickel, 0.05 % ruthenium),

1.1.12 *Grade 14*—Titanium alloy (0.5 % nickel, 0.05 % ruthenium),

1.1.13 *Grade 15*—Titanium alloy (0.5 % nickel, 0.05 % ruthenium),

1.1.14 *Grade 16*—Unalloyed titanium plus 0.04 % to 0.08 % palladium, standard oxygen,

1.1.15 *Grade 17*—Unalloyed titanium plus 0.04 % to 0.08 % palladium, low oxygen,

1.1.16 *Grade 18*—Titanium alloy (3 % aluminum, 2.5 % vanadium) plus 0.04 % to 0.08 % palladium,

1.1.17 *Grade 19*—Titanium alloy (3 % aluminum, 8 % vanadium, 6 % chromium, 4 % zirconium, 4 % molybdenum),

1.1.18 *Grade 20*—Titanium alloy (3 % aluminum, 8 % vanadium, 6 % chromium, 4 % zirconium, 4 % molybdenum) plus 0.04 % to 0.08 % palladium,

1.1.19 *Grade 21*—Titanium alloy (15 % molybdenum, 3 % aluminum, 2.7 % niobium, 0.25 % silicon),

1.1.20 *Grade 23*—Titanium alloy (6 % aluminum, 4 % vanadium with extra low interstitial elements, ELI),

1.1.21 *Grade 24*—Titanium alloy (6 % aluminum, 4 % vanadium) plus 0.04 % to 0.08 % palladium,

1.1.22 *Grade 25*—Titanium alloy (6 % aluminum, 4 % vanadium) plus 0.3 % to 0.8 % nickel and 0.04 % to 0.08 % palladium,

1.1.23 *Grade 26*—Unalloyed titanium plus 0.08 to 0.14 % ruthenium,

1.1.24 *Grade 27*—Unalloyed titanium plus 0.08 to 0.14 % ruthenium,

1.1.25 *Grade 28*—Titanium alloy (3 % aluminum, 2.5 % vanadium) plus 0.08 to 0.14 % ruthenium,

1.1.26 *Grade 29*—Titanium alloy (6 % aluminum, 4 % vanadium with extra low interstitial elements, ELI) plus 0.08 to 0.14 % ruthenium,

1.1.27 *Grade 32*—Titanium alloy (5 % aluminum, 1 % tin, 1 % vanadium, 1 % zirconium, 0.8 % molybdenum),

1.1.28 *Grade 33*—Titanium alloy (0.4 % nickel, 0.015 % palladium, 0.025 % ruthenium, 0.15 % chromium),

1.1.29 *Grade 34*—Titanium alloy (0.4 % nickel, 0.015 % palladium, 0.025 % ruthenium, 0.15 % chromium),

1.1.30 *Grade 35*—Titanium alloy (4.5 % aluminum, 2 % molybdenum, 1.6 % vanadium, 0.5 % iron, 0.3 % silicon),

1.1.31 *Grade 36*—Titanium alloy (45 % niobium),

1.1.32 *Grade 37*—Titanium alloy (1.5 % aluminum), and

1.1.33 *Grade 38*—Titanium alloy (4 % aluminum, 2.5 % vanadium, 1.5 % iron).

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to DI units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

E 8 Test Methods for Tension Testing of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

[1] This specification is under the jurisdiction of ASTM Committee B10 on Reactive and Refractory Metals and Alloys and is the direct responsibility of Subcommittee B10.01 on Titanium.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

E 120 Test Methods for Chemical Analysis of Titanium and Titanium Alloys[3]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *coils*, *n*—wire in coil form with pitch and cast as described by purchaser.

3.1.2 *straight lengths*, *n*—wire in straight lengths, generally made by straightening wire from coils by the producer.

3.1.3 *weld wire*, *n*—round wire for welding.

3.1.4 *wire*, *n*—rounds, flats, or special shapes from 0.020 in. (0.5 mm) to 0.250 in. (6.4 mm) in thickness or major dimension.

[3] Withdrawn.

TABLE 1 Chemical Requirements[A]

Element	Composition, %										
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 9	Grade 11	Grade 12	Grade 13
Nitrogen, max	0.03	0.03	0.05	0.05	0.05	0.03	0.03	0.03	0.03	0.03	0.03
Carbon, max	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Hydrogen,[B,C] max	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015
Iron, max	0.20	0.30	0.30	0.50	0.40	0.50	0.30	0.25	0.20	0.30	0.20
Oxygen, max	0.18	0.25	0.35	0.40	0.20	0.20	0.25	0.15	0.18	0.25	0.10
Aluminum	...	...	...	...	5.5–6.75	4.0–6.0	...	2.5–3.5	...	...	...
Vanadium	...	...	...	...	3.5–4.5	...	...	2.0–3.0	...	...	...
Tin	...	...	...	...	...	2.0–3.0	...	...	...	...	...
Ruthenium	...	...	...	...	...	...	...	...	...	...	0.04–0.06
Palladium	...	...	...	...	...	...	0.12–0.25	...	0.12–0.25	...	...
Cobalt	...	...	...	...	...	...	...	...	...	...	...
Molybdenum	...	...	...	...	...	...	...	...	...	0.2–0.4	...
Chromium	...	...	...	...	...	...	...	...	...	...	...
Nickel	...	...	...	...	...	...	...	...	...	0.6–0.9	0.4–0.6
Niobium	...	...	...	...	...	...	...	...	...	...	...
Zirconium	...	...	...	...	...	...	...	...	...	...	...
Silicon	...	...	...	...	...	...	...	...	...	...	...
Residuals,[D,E,F] max each	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residuals,[D,E,F] max total	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Titanium[G]	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance

Element	Composition, %										
	Grade 14	Grade 15	Grade 16	Grade 17	Grade 18	Grade 19	Grade 20	Grade 21	Grade 23	Grade 24	Grade 25
Nitrogen, max	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05
Carbon, max	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	0.08	0.08	0.08
Hydrogen,[B,C] max	0.015	0.015	0.015	0.015	0.015	0.02	0.02	0.015	0.0125	0.015	0.0125
Iron, max	0.30	0.30	0.30	0.20	0.25	0.30	0.30	0.40	0.25	0.40	0.40
Oxygen, max	0.15	0.25	0.25	0.18	0.15	0.12	0.12	0.17	0.13	0.20	0.20
Aluminum	...	...	...	...	2.5–3.5	3.0–4.0	3.0–4.0	2.5–3.5	5.5–6.5	5.5–6.75	5.5–6.75
Vanadium	...	...	...	...	2.0–3.0	7.5–8.5	7.5–8.5	...	3.5–4.5	3.5–4.5	3.5–4.5
Tin	...	...	...	...	...	...	...	...	...	...	...
Ruthenium	0.04–0.06	0.04–0.06	...	...	...	...	...	...	...	...	...
Palladium	...	...	0.04–0.08	0.04–0.08	0.04–0.08	...	0.04–0.08	...	...	0.04–0.08	0.04–0.08
Cobalt	...	...	...	...	...	...	...	...	...	...	...
Molybdenum	...	...	...	...	...	3.5–4.5	3.5–4.5	14.0–16.0	...	...	...
Chromium	...	...	...	...	...	5.5–6.5	5.5–6.5	...	...	...	...
Nickel	0.4–0.6	0.4–0.6	...	...	...	...	...	...	...	...	0.3–0.8
Niobium	...	...	...	...	...	...	...	2.2–3.2	...	...	...
Zirconium	...	...	...	...	...	3.5–4.5	3.5–4.5	...	...	...	...
Silicon	...	...	...	...	...	...	...	0.15–0.25	...	...	...
Residuals,[D,E,F] max each	0.1	0.1	0.1	0.1	0.1	0.15	0.15	0.1	0.1	0.1	0.1
Residuals,[D,E,F] max total	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Titanium[G]	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance

TABLE 1 *Continued*

Element	Composition, %										
	Grade 26	Grade 27	Grade 28	Grade 29	Grade 32	Grade 33	Grade 34	Grade 35	Grade 36	Grade 37	Grade 38
Nitrogen, max	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05	0.03	0.03	0.03
Carbon, max	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.04	0.08	0.08
Hydrogen,[B,C] max	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.0035	0.015	0.015
Iron, max or range	0.30	0.20	0.25	0.25	0.25	0.30	0.30	0.20–0.80	0.03	0.30	1.2–1.8
Oxygen, max or range	0.25	0.18	0.15	0.13	0.11	0.25	0.35	0.25	0.16	0.25	0.20–0.30
Aluminum	...	...	2.5–3.5	5.5–6.5	4.5-5.5	...	...	4.0–5.0	...	1.0–2.0	3.5–4.5
Vanadium	...	...	2.0–3.0	3.5–4.5	0.6-1.4	...	...	1.1–2.1	...	...	2.0–3.0
Tin	...	...	...	...	0.6-1.4	...	...	...	...	...	...
Ruthenium	0.08–0.14	0.08–0.14	0.08–0.14	0.08–0.14	...	0.02-0.04	0.02-0.04	...	...	...	...
Palladium	...	...	...	...	...	0.01-0.02	0.01-0.02	...	...	...	...
Cobalt	...	...	...	...	...	...	...	...	...	...	...
Molybdenum	...	...	...	...	0.6-1.2	...	...	1.5–2.5	...	...	...
Chromium	...	...	...	...	...	0.1-0.2	0.1-0.2	...	...	...	...
Nickel	...	...	...	...	...	0.35-0.55	0.35-0.55	...	...	...	...
Niobium	...	...	...	...	...	...	...	...	42.0–47.0	...	...
Zirconium	...	...	...	...	0.6-1.4	...	...	...	...	...	...
Silicon	...	...	...	...	0.06-0.14	...	...	0.20–0.40	...	...	...
Residuals,[D,E,F] max each	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residuals,[D,E,F] max total	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Titanium[G]	balance	balance	balance	balance	balance	Remainder	Remainder	Remainder	Remainder	Remainder	balance

[A] Analysis shall be completed for all elements listed in this table for each grade. The analysis results for the elements not quantified in the table need not be reported unless the concentration level is greater than 0.1 % each or 0.4 % total.
[B] Lower hydrogen may be obtained by negotiation with the manufacturer.
[C] Final product analysis.
[D] Need not be reported.
[E] A residual is an element present in a metal or an alloy in small quantities and is inherent to the manufacturing process but not added intentionally. In titanium these elements include aluminum, vanadium, tin, chromium, molybdenum, niobium, zirconium, hafnium, bismuth, ruthenium, palladium, yttrium, copper, silicon, cobalt, tantalum, nickel, boron, manganese, and tungsten.
[F] The purchaser may, in his written purchase order, request analysis for specific residual elements not listed in this specification.
[G] The percentage of titanium is determined by difference.

4. Product Classification

4.1 *Wire*—See 3.1.4.

4.2 *Coils*—Coiled wire may be spooled on spools if required by the user.

4.3 *Straight Lengths*—After straightening, it may be necessary to perform cleaning or other finishing operations. Straight lengths are normally 10 to 12 ft long (random). Exact lengths may be specified by the purchaser when necessary.

4.4 *Weld Wire*—Weld wire usually has a degree of cold work to provide sufficient stiffness to feed from spools in automatic welders. Weld wire is delivered on standard spools as described by the user, or in packages of straight lengths for manual welding operations. There are no tensile strength requirements for the weld wire; however, the chemical analysis of the wire will conform to Table 1.

5. Ordering Information

5.1 . Orders for material under this specification shall include the following information as applicable:

5.1.1 Grade number (Section 1),

5.1.2 Product description (Sections 3 and 4),

5.1.3 Chemistry (Table 1),

5.1.4 Mechanical properties (if applicable, Table 2),

5.1.5 Marking and packaging (Section 17),

5.1.6 Finish (Section 9),

5.1.7 Applicable dimensions including size, thickness, width, spool size, coil diameter, and length (exact, random, multiples) or print number,

5.1.8 Required reports (Section 16),

5.1.9 Special tests or requirements, and

5.1.10 Disposition of rejected material (Section 15).

6. Chemical Composition

6.1 The grades of titanium and titanium alloy metal covered by this specification shall conform to the requirements as to chemical composition prescribed in Table 1.

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

6.1.1.1 Elements other than those listed in Table 1 are deemed to be capable of occurring in the grades listed in Table 1 by and only by way of unregulated or unanalyzed scrap additions to the ingot melt. Therefore, product analysis for elements not listed in Table 1 shall not be required unless specified and shall be considered to be in excess of the intent of this specification.

6.1.2 Elements intentionally added to the melt must be identified, analyzed and reported in the chemical analysis.

6.2 When agreed upon by the producer and purchaser and requested by the purchaser in his written purchase order, chemical analysis shall be completed for specific residual elements not listed in this specification.

TABLE 2 Tensile Requirements

Grade	Tensile Strength		Yield Strength (0.2 % Offset)		Elongation[A]
	minimum		minimum		min,%
	ksi	MPa	ksi	MPa	
1	35	(240)	20	(138)	20
2	50	(345)	40	(275)	18
3	65†	(450)†	55	(380)	18
4	80†	(550)†	70	(483)	15
5	130	(895)	120	(828)	10
6	120	(828)	115	(793)	10
7	50	(345)	40	(275)	18
9	90	(620)	70	(483)	15
11	35	(240)	20	(138)	20
12	70	(483)	50	(345)	18
13	40	(275)	25	(170)	18
14	50	(410)	40	(275)	20
15	70	(483)	50	(345)	15
16	50	(345)	40	(275)	20
17	35	(240)	20	(138)	20
18	90	(620)	70	(483)	10
19[B,C]	115	(793)	110	(759)	10
20[B,C]	115	(793)	110	(759)	10
21[B,C]	115	(793)	110	(759)	10
23	115	(793)	110	(759)	10
24	130	(895)	120	(828)	10
25	130	(895)	120	(828)	10
26	50	(345)	40	(275)	20
27	35	(240)	20	(138)	24
28	90	(620)	70	(483)	15
29	120	(828)	110	(759)	10
32	100	689	85	586	10
33	50	(345)	40	(275)	20
34	65	(450)	55	(380)	18
35	130	(895)	120	(828)	5
36	65	(450)	60	(410)	10
37	50	(345)	31	(215)	18
38	130	(895)	115	(794)	10

[A] Elongation shall be measured as described in 7.2.1 and 7.2.2.
[B] Properties for material in the solution treated condition.
[C] Material is normally purchased in the solution treated condition. Therefore, properties for aged material shall be negotiated between manufacturer and purchaser.

† Tensile strength for Grade 3 and Grade 4 was corrected editorially.

TABLE 3 Permissible Variations in Product Analysis

Element	Product Analysis Limits, max or range,%	Permissible Variation in Product Analysis
Aluminum	0.5 to 2.5	±0.20
Aluminum	2.5 to 6.75	±0.40
Carbon	0.10	+0.02
Chromium	0.1 to 0.2	±0.02
Chromium	5.5 to 6.5	±0.30
Hydrogen	0.02	+0.002
Iron	0.80	+0.15
Iron	1.2 to 1.8	±0.20
Molybdenum	0.2 to 0.4	±0.03
Molybdenum	0.6 to 1.2	±0.15
Molybdenum	1.5 to 4.5	±0.20
Molybdenum	14.0 to 16.0	±0.50
Nickel	0.3 to 0.9	±0.05
Niobium	2.2 to 3.2	±0.15
Niobium	>30	±0.50
Nitrogen	0.05	+0.02
Oxygen	0.30	+0.03
Oxygen	0.31 to 0.40	±0.04
Palladium	0.01 to 0.02	±0.002
Palladium	0.04 to 0.08	±0.005
Palladium	0.12 to 0.25	±0.02
Ruthenium	0.02 to 0.04	±0.005
Ruthenium	0.04 to 0.06	±0.005
Ruthenium	0.08 to 0.14	±0.01
Silicon	0.06 to 0.40	±0.02
Tin	0.6 to 3.0	±0.15
Vanadium	0.6 to 4.5	±0.15
Vanadium	7.5 to 8.5	±0.40
Zirconium	0.6 to 1.4	±0.15
Zirconium	3.5 to 4.5	±0.20
Residuals[A] (each)	0.15	+0.02

[A] A residual is an element in a metal or alloy in small quantities inherent to the manufacturing process but not added intentionally.

6.3 *Product Analysis*—Product analysis tolerances do not broaden the specified heat analysis requirements, but cover variations between laboratories in the measurement of chemical content. The manufacturer shall not ship material which is outside the limits specified in Table 1 for the applicable grade. Product analysis limits shall be as specified in Table 3.

7. Mechanical Requirements

7.1 Annealed material supplied under this specification shall conform to the mechanical property requirements given in Table 2, as applicable. Material may be ordered in the cold worked condition to higher ultimate tensile strengths and lower elongation levels as agreed upon between the supplier and the purchaser.

7.2 Tension testing shall be performed in accordance with Test Methods E 8. Tensile properties shall be determined using a strain rate of 0.003 to 0.007 in./in./min. (SI equivalent mm/mm/min) through the yield strength, and then the crosshead speed shall be increased so as to produce fracture in approximately one additional minute.

7.2.1 Wire and shapes with the diameter or smallest dimension between 0.250 and 0.125 in. (6.4 to 3.2 mm) shall have the yield strength determined in accordance with Test Methods E 8, and the elongation measured and reported over 4*D* (4 diameters).

7.2.2 Wire and shapes with the diameter or smallest dimension less than 0.125 in. (3.2 mm) shall have the elongation determined over 2 in. (50.8 mm) unless defined otherwise by the purchaser. The reported value shall be expressed as a percentage elongation in 1 in. or equivalent.

7.3 The yield strength requirements in Table 2 only apply to sizes of 0.125 in. (3.2 mm) and above.

8. Dimensions, Weight, and Permissible Variations

8.1 *Size*—Tolerances on diameter of titanium and titanium alloy material covered by this specification shall be as specified in Table 4.

8.2 *Weight*—The shipping weight of any item of an ordered size in any finish condition may exceed the theoretical weight by as much as 10 %.

TABLE 4 Permissible Variations in Size for Titanium Wire

Specified Diameter, in. (dimension if shape wire)	Variation, in.	
	Wire as Coil or on Spools	Cut Straight Lengths[A]
0.020 to 0.045, incl	±0.001	±0.0015
over 0.045 to 0.062, incl	±0.015	±0.002
over 0.062 to 0.090, incl	±0.002	±0.0025
over 0.090 to 0.187, incl	±0.003	±0.003
over 0.187 to 0.250	±0.004	±0.004

[A] Length tolerance for cut lengths is ±0.25 in. for lengths up to and including 36 in.

9. Workmanship, Finish, and Appearance

9.1 Titanium and titanium alloy wire shall be free of injurious external and internal imperfections of a nature that will interfere with the purpose for which the wire is intended. Material may be furnished as polished, chemically cleaned, ground, or mechanically descaled, and shall have a clean, contamination-free surface.

9.1.1 For specific applications, a final sizing draw pass may be specified, with lubricants to be applied (or allowed to remain) on the wire.

10. Chemical Analysis

10.1 Samples for chemical analysis shall be representative of the material being tested. The utmost care must be used in sampling titanium for chemical analysis because of its great affinity for elements such as oxygen, nitrogen, and hydrogen. Therefore, in cutting samples for analysis, the operation should be carried out insofar as possible in a dust-free atmosphere. Chips should be collected from clean metal and tools should be clean and sharp. Hydrogen analysis shall be performed on the final cleaned wire product.

11. Methods of Chemical Analysis

11.1 The chemical analysis shall be conducted by the standard techniques normally utilized by the manufacturer and the purchaser. In case of disagreement Test Methods E 120 shall be used as the referee method, except for carbon and hydrogen, which are not covered in Test Methods E 120.

12. Retests

12.1 If the results of a chemical or mechanical property test lot are not in conformance with the requirements of this specification, the lot may be retested at the option of the manufacturer. The frequency of the retest will double the initial number of tests. If the results of the retest conform to the specification, then the retest values will become the test values for certification. Only original conforming test results or the conforming retest results shall be reported to the purchaser. If the results for the retest fail to conform to the specification, the material will be rejected in accordance with Section 15.

13. Referee Test and Analysis

13.1 In the event of a disagreement between the manufacturer and the purchaser on the conformance of the material to the requirements of this specification, a mutually acceptable referee shall perform the tests in question. The referee's testing shall be used in determining conformance of the material to this specification.

14. Rounding-Off Procedure

14.1 For purposes of determining conformance with the specifications contained herein, an observed or a calculated value shall be rounded off to the nearest unit in the last right-hand significant digit used in expressing the limiting value. This is in accordance with the round-off method of Practice E 29.

15. Rejection

15.1 Material not conforming to this specification or to authorized modifications shall be subject to rejection. Unless otherwise specified, rejected material may be returned to the manufacturer at the manufacturer's expense, unless the purchaser receives, within three weeks of notice of rejection, other instructions for disposition.

16. Certification

16.1 If so requested by the purchaser, the manufacturer shall supply at least one copy of his report certifying that the material supplied has been inspected and tested in accordance with the requirements of this specification and that the results of chemical analysis and mechanical tests meet the requirements of this specification for the appropriate grade.

17. Packaging and Package Marking

17.1 *Marking*—Unless otherwise specified, individual packages of straight wires or coils of wire shall have attached an appropriate tag containing the purchase order number, the specification number, the alloy, the nominal size, and the manufacturer's lot number, or the product shall be boxed and the box marked with the same information.

17.2 *Packaging*—Unless otherwise specified, material purchased under this specification may be packaged for shipment by boxing or crating with adequate protection in accordance with the manufacturer's standard practice.

18. Keywords

18.1 titanium; titanium alloy; weld wire; wire