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Standard Specification for Titanium and Titanium Alloy Wire¹

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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), and

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

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 ASTM Standards:²

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

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

E 120 Test Methods for Chemical Analysis of Titanium and Titanium Alloys

E 1409 Test Method for Determination of Oxygen in Titanium and Titanium Alloys by the Inert Gas Fusion Technique

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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 1447 Test Method for Determination of Hydrogen in Titanium and Titanium Alloys by the Inert Gas Fusion Thermal Conductivity Method

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 0.1875 in. (4.8 mm) in thickness or major dimension.

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.

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	
Nitrogen, max	0.03	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	
Carbon, max	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	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	
Iron, max	0.30	0.30	0.30	0.20	0.25	0.30	0.30	0.40	0.25	0.40	
Oxygen, max	0.15	0.25	0.25	0.18	0.15	0.12	0.12	0.17	0.13	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
Vanadium	...	...	...	...	2.0–3.0	7.5–8.5	7.5–8.5	...	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
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	...	...	...	...	...	...	...	...
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	
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	
Titanium ^G	balance	balance	balance	balance	balance	balance	balance	balance	balance	balance	