



Designation: B 863 – 05^{ε1}

Standard Specification for Titanium and Titanium Alloy Wire¹

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^{ε1} NOTE—Tensile strength for Grade 3 and Grade 4 in Table 2 was corrected editorially in January 2006.

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

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI 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

¹ This specification is under the jurisdiction of ASTM Committee B10 on Reactive and Refractory Metals and Alloys and is under 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 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 Alloys³

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 | |
| 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 | |