



Designation: B392 – 09^{ε1}

Standard Specification for Niobium and Niobium Alloy Bar, Rod, and Wire¹

This standard is issued under the fixed designation B392; 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.

^{ε1} NOTE—Editorial corrections were made throughout in January 2010.

1. Scope

1.1 This specification covers four grades of wrought niobium and niobium alloy bar, rod, and wire as follows:

1.1.1 *R04200-Type 1*—Reactor grade unalloyed niobium,

1.1.2 *R04210-Type 2*—Commercial grade unalloyed niobium,

1.1.3 *R04251-Type 3*—Reactor grade niobium alloy containing 1 % zirconium, and

1.1.4 *R04261-Type 4*—Commercial grade niobium alloy containing 1 % zirconium.

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.

1.3 *The following precautionary caveat pertains only to the test methods portion of this specification. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

B391 Specification for Niobium and Niobium Alloy Ingots

E8 Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals

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 B10.03 on Niobium and Tantalum.

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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.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot, n*—a lot shall consist of all material produced from the same ingot at one time, with the same cross section, processed with the same nominal metallurgical parameters and heat treated at the same conditions.

3.1.2 *bar, n*—material less than 6 in. (152.4 mm) in width and 0.187 in. (4.75 mm) or greater in thickness, with a rectangular cross section, supplied in straight lengths.

3.1.3 *rod, n*—material 0.125 to 2.50 in. (3.18 to 63.50 mm) in diameter, in round, hexagonal, or octagonal cross section supplied in straight lengths.

3.1.4 *wire, n*—material 0.020 to 0.124 in. (0.51 to 3.15 mm) in diameter, furnished in coils or on spools or reels. Material less than 0.020 in. (0.51 mm) in diameter is not covered by this specification.

4. Ordering Information

4.1 Orders for materials under this specification shall include the following information as applicable:

- 4.1.1 Type and grade (Section 1),
- 4.1.2 ASTM designation and year of issue,
- 4.1.3 Method of manufacture (Section 5),
- 4.1.4 Temper designation (Section 8),
- 4.1.5 Quantity in weight, number of pieces, and dimensions,
- 4.1.6 Chemistry (6.3),
- 4.1.7 Mechanical properties (Section 7),
- 4.1.8 Condition (8.2),
- 4.1.9 Permissible Variations (9.2),
- 4.1.10 Permissible overshipments (9.4),
- 4.1.11 Quality and finish (Section 10),
- 4.1.12 Sampling (Section 11),
- 4.1.13 Inspection (Section 15),
- 4.1.14 Required reports (Section 17), and
- 4.1.15 Additions to the specification and supplementary requirements, as required.

5. Materials and Manufacture

5.1 Material covered by this specification shall be made from ingots that conform to Specification B391 and that are

produced by vacuum or plasma arc melting, vacuum electron-beam melting, or a combination of these three methods.

5.2 The various niobium mill products covered by this specification are formed with the conventional extrusion, forging, swaging, rolling, and drawing equipment normally available in metal working plants.

6. Chemical Requirements

6.1 The niobium and niobium alloy ingots and billets for conversion to finished products covered by this specification shall conform to the requirements for chemical composition as prescribed in Table 1.

6.2 The manufacturer’s ingot analysis shall be considered the chemical analysis for products supplied under this specification, except for interstitials as specified in 6.3. Alternately, an analysis of a representative sample of in process or final product from the same ingot may be substituted.

6.3 When requested by the purchaser at the time of purchase, the manufacturer shall furnish a report certifying the values of the interstitial elements (C, O, N, H) on end product, as prescribed in Table 2 for each lot of material supplied. End product interstitial samples must be taken after all thermal and chemical processing.

6.4 Guide E2626 is recommended as a guide, where applicable.

7. Mechanical Requirements

7.1 The annealed materials supplied under this specification shall conform to the requirements for mechanical properties as specified in Table 3.

TABLE 2 Additional Chemical Requirements for Finished Product (When Specified by the Purchaser)

Element	Type 1 (Reactor Grade Unalloyed Niobium) R04200	Type 2 (Commercial Grade Unalloyed Niobium) R04210	Type 3 (Reactor Grade Niobium—1 % Zirconium) R04251	Type 4 (Commercial Grade Niobium—1 % Zirconium) R04261
	Maximum Weight %			
Oxygen	0.0250	0.0400	0.0250	0.0400
Carbon	0.0100	0.0150	0.0100	0.0150
Nitrogen	0.0100	0.0100	0.0100	0.0100
Hydrogen	0.0015	0.0015	0.0015	0.0015

TABLE 3 Mechanical Properties, Annealed Condition (90 % Minimum Recrystallized)

Grade	Ultimate Tensile Strength, Min, psi (MPa)	Yield Strength, psi (MPa)	Elongation min %, mm ^A
	Rod, 0.125 in. (3.18 mm) to 2.5 in. (63.5 mm) diameter		
Types 1 and 2	18 000 (125)	10 500 (73)	25
Types 3 and 4	28 000 (195)	18 000 (125)	20
Wire, 0.020 in. (0.51 mm) to 0.124 in. (3.15 mm)			
Types 1 and 2	18 000 (125)	...	20
Types 3 and 4	28 000 (195)	...	15

^A 10 in. (254 mm) gage length to 0.050 in. (1.27 mm) diameter, and 1 in. (25.4 mm) or 2 in. (50.8 mm) gage length equal to or over 0.050 in. (1.27 mm).

8. Temper Designations

8.1 Unless otherwise stated, the materials supplied under these specifications shall be in the fully annealed condition, that is, at least 90 % recrystallized.

8.2 Other temper designations, such as cold-worked temper or stress-relieved temper, can be specified as agreed upon between the purchaser and the manufacturer at the time of purchase.

9. Permissible Variations in Dimensions and Weight

9.1 *Tolerances on Rounds*—Tolerances on niobium and niobium alloy round products covered by this specification shall be as prescribed in Table 4.

9.2 *Tolerances for Square, Rectangular, or Other Shapes*—Tolerances for forged or rolled square, rectangular, or other shapes shall be as agreed upon between the purchaser and the manufacturer at the time of purchase.

TABLE 4 Permissible Variations in Dimensions for Rolled, Swaged, or Drawn Rod and Wire

Diameter, in. (mm)	Tolerances, plus or minus, in. (mm)
0.020–0.030 excl (0.51–0.76)	0.00075 (0.019)
0.030–0.060 excl (0.76–1.52)	0.001 (0.025)
0.060–0.090 excl (1.52–2.29)	0.0015 (0.038)
0.090–0.125 excl (2.29–3.18)	0.002 (0.051)
0.125–0.187 excl (3.18–4.75)	0.003 (0.076)
0.187–0.375 excl (4.75–9.53)	0.004 (0.102)
0.375–0.500 excl (9.53–12.7)	0.005 (0.127)
0.500–0.625 excl (12.7–15.9)	0.007 (0.178)
0.625–0.750 excl (15.9–19.1)	0.008 (0.203)
0.750–1.000 excl (19.1–25.4)	0.010 (0.254)
1.000–1.500 excl (25.4–38.1)	0.015 (0.381)
1.500–2.000 excl (38.1–50.8)	0.020 (0.508)
2.000–2.500 incl (50.8–63.5)	0.030 (0.762)

TABLE 1 Chemical Requirements

Element	Type 1 (Reactor Grade Unalloyed Niobium) R04200	Type 2 (Commercial Grade Unalloyed Niobium) R04210	Type 3 (Reactor Grade Niobium- 1 % Zirconium) R04251	Type 4 (Commercial Grade Niobium- 1 % Zirconium) R04261
	Max Weight % (Except Where Otherwise Specified)			
Each Ingot:				
Carbon	0.01	0.01	0.01	0.01
Nitrogen	0.01	0.01	0.01	0.01
Oxygen	0.015	0.025	0.015	0.025
Hydrogen	0.0015	0.0015	0.0015	0.0015
Zirconium	0.02	0.02	0.8 to 1.2 (range)	0.8 to 1.2 (range)
Tantalum	0.1	0.3	0.1	0.5
Iron	0.005	0.01	0.005	0.01
Silicon	0.005	0.005	0.005	0.005
Tungsten	0.03	0.05	0.03	0.05
Nickel	0.005	0.005	0.005	0.005
Molybdenum	0.010	0.020	0.010	0.050
Hafnium	0.02	0.02	0.02	0.02
Titanium	0.02	0.03	0.02	0.03
When Specified:				
Boron	2 ppm	...	2 ppm	...
Aluminum	0.002	0.005	0.002	0.005
Beryllium	0.005	...	0.005	...
Chromium	0.002	...	0.002	...
Cobalt	0.002	...	0.002	...