



Designation: B392 – 03

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

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1. Scope

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

NOTE 1—Committee B10 has adopted “niobium” as the designation for Element No. 41, formerly named “columbium.”

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 the standard. The values given in parentheses are for information only.

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 Ingots³

E8 Test Methods for Tension Testing of Metallic Materials⁴

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:* Descriptions of Terms Specific to This Standard:

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 *Annual Book of ASTM Standards*, Vol 02.04.

³ *Annual Book of ASTM Standards*, Vol 03.01.

⁴ *Annual Book of ASTM Standards*, Vol 14.02.

3.1.1 *lot*—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*—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*—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*—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 overshoots (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 and Hardness Requirements Chemical and Hardness 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 and hardness as prescribed in Table 1 and Table 2.

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.

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) as prescribed in Table 3 for each lot of material supplied.

7. Mechanical Requirements

7.1 The annealed materials supplied under this specification shall conform to the requirements for mechanical properties as specified in Table 4.

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 5.

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	...

TABLE 2 Brinell Hardness

	Type 1	Type 2	Type 3	Type 4
Maximum average	90	125	125	135
Maximum per individual impression	105	150	140	150

TABLE 3 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 4 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

^A10 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).

TABLE 5 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)

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.

9.3 Other Tolerances and Limitations:

9.3.1 The permissible variations in cut lengths shall not exceed a total of 0.25 in. (6.35 mm).

9.3.2 The permissible variation in straightness of rounds shall not exceed 0.050 in./ft (4.2 mm/m) in any length.

9.4 Quantity or Weight—For orders requiring up to 100 ft (30.5 m) of finished product, the manufacturer may overship by 20 %. When the order is for quantities up to 1000 ft (305 m) or 1000 lb (453.6 kg), the manufacturer may overship by 10 %.