



Designation: B 393 – 03

Standard Specification for Niobium and Niobium Alloy Strip, Sheet, and Plate¹

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1. Scope

1.1 This specification covers four grades of wrought niobium and niobium alloy strip, sheet, and plate 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 Except for dimensional tolerances in Table 1, 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:*

B 391 Specification for Niobium and Niobium Alloy Ingots²

E 8 Test Methods for Tension Testing of Metallic Materials³

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁴

3. Terminology

3.1 *Definitions 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 *plate*—a flat product 6 in. (152.4 mm) or more in width and greater than $\frac{3}{16}$ in. (4.76 mm) in thickness.

3.1.3 *sheet*—a flat product 6 in. (152.4 mm) or more in width and from 0.005 in. (0.13 mm) to $\frac{3}{16}$ in. (4.76 mm) in thickness.

3.1.4 *strip*—a flat product, which may be supplied in coil, less than 6 in. (152.4 mm) in width and from 0.005 in. (0.13 mm) to $\frac{3}{16}$ in. (4.76 mm) in thickness.

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 Quantity in weight, number of pieces, and dimensions,

4.1.4 Chemistry (6.3),

4.1.5 Temper designation (Section 8),

4.1.6 Permissible overshipment (9.3),

4.1.7 Quality and finish (10.3),

4.1.8 Sampling (11.2),

4.1.9 Inspection (Section 15),

4.1.10 Required reports (Section 17),

4.1.11 Marking (Section 18), and

4.1.12 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 B 391 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.

TABLE 1 Dimensional Tolerances for Niobium Flat-Rolled Products

Thickness of Material, in. (mm) in lower table	Tolerance on Thickness ^A plus or minus, in. (mm) in lower table		Tolerance on Width (slit) ^B plus or minus, in.(mm) in lower table		Tolerance on Sheared Lengths, in. (mm)			
	Width under 6 in. or 152.4 mm	Width 6 to 24 in. or 152.4 to 609.6 mm	Width under 6 in. or 152.4 mm	Width 6 to 24 in. or 152.4 to 609.6 mm	Length 12 in. or 304.8 mm and under		Length over 12 in. or 304.8 mm	
					Plus	Minus	Plus	Minus
Inches								
0.005 to 0.010 excl	0.0005	0.001	0.012	...	1/16	0	3/32	0
0.010 to 0.015 excl	0.0007	0.001	0.015	0.015	1/16	0	3/32	0
0.015 to 0.020 excl	0.0008	0.0015	0.015	0.015	1/16	0	3/32	0
0.020 to 0.030 excl	0.0015	0.0025	0.020	0.025	1/16	0	3/32	0
0.030 to 0.060 excl	0.0025	0.0035	0.025	0.030	1/16	0	3/32	0
0.060 to 0.090 excl	0.004	0.005	0.025	0.035	1/16	0	3/32	0
0.090 to 0.125 excl	0.006	0.007	...	...	1/16	0	3/32	0
0.125 to 0.187 excl	0.010	0.010	...	...	1/16	0	3/32	0
0.187 to 0.250 excl	0.015	0.015	...	...	1/8	0	5/32	0
0.250 to 0.312 excl	0.020	0.020	...	...	1/8	0	5/32	0
0.312 to 0.375 excl	0.025	0.025	...	...	3/16	0	7/32	0
Millimetres								
0.13 to 0.254 excl	0.013	0.025	0.30	...	1.59	0	2.38	0
0.254 to 0.381 excl	0.018	0.025	0.38	0.38	1.59	0	2.38	0
0.381 to 0.508 excl	0.020	0.038	0.38	0.38	1.59	0	2.38	0
0.508 to 0.762 excl	0.038	0.064	0.51	0.64	1.59	0	2.38	0
0.762 to 1.524 excl	0.064	0.089	0.64	0.76	1.59	0	2.38	0
1.524 to 2.286 excl	0.102	0.127	0.64	0.89	1.59	0	2.38	0
2.286 to 3.175 excl	0.15	0.18	...	...	1.59	0	2.38	0
3.175 to 4.75 excl	0.25	0.25	...	...	1.59	0	2.38	0
4.75 to 6.35 excl	0.38	0.38	...	...	3.18	0	3.97	0
6.35 to 7.925 excl	0.51	0.51	...	...	3.18	0	3.97	0
7.925 to 9.52 excl	0.64	0.64	...	...	4.76	0	5.56	0

^ATolerance on thickness of sheet over 24 in. (610 mm) wide shall be $\pm 10\%$ of the thickness.

^BTolerance on width of sheared sheet shall be $\pm 1/16$ in. (± 1.6 mm) and on sheared plate shall be $\pm 1/8$ in. (± 3.2 mm) up to material thickness of 0.375 in. (9.5 mm).

6. 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 2 and Table 3.

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 4 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 5.

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.

TABLE 2 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	...