Designation: B 521 – 98 (Reapproved 2004)

Standard Specification for Tantalum and Tantalum Alloy Seamless and Welded Tubes[1]

This standard is issued under the fixed designation B 521; 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.

1. Scope

1.1 This specification covers tantalum and tantalum alloy seamless and welded tubes of the following grades:

1.1.1 *UNS Grade R05400*—Unalloyed tantalum, powder-metallurgy consolidation,

1.1.2 *UNS Grade R05200*—Unalloyed tantalum, vacuum melted,

1.1.3 *UNS Grade R05252*—Tantalum + 2.5 % tungsten alloy, vacuum melted.

1.1.4 *UNS Grade R05255*—Tantalum + 10 % tungsten alloy, vacuum melted.

1.1.5 *UNS Grade R05240*—Tantalum alloy, 60 % tantalum, 40 % columbium, electron-beam furnace or vacuum arc melt, or both.

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]

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

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *lot*—all material produced from the same ingot or single powder blend, of the same size and last annealed in the same furnace charge.

3.1.2 *process length*—the one-piece length of each tube that results from the production operation that first yields the tubular form. Sampling and testing should in general be based on process lengths unless specifically stated otherwise.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Quantity,

4.1.2 UNS grade,

4.1.3 Type (welded or seamless),

4.1.4 Dimensions,

4.1.5 Nondestructive test requirements, if any, and

4.1.6 Additions to the specification and supplementary requirements, if any.

5. Materials and Manufacture

5.1 Seamless tube shall be made by any seamless method that will yield a product meeting the requirements of this specification.

5.2 Welded tube shall be made from flat-rolled product by an automatic or semiautomatic fusion welding process with no addition of filler metal.

6. Chemical Composition

6.1 The material shall conform to the requirements of chemical composition prescribed in Table 1.

6.1.1 Analysis for elements not listed in Table 1 and not normally expected in tantalum shall not be required unless specified at time of purchase.

6.2 The manufacturer's ingot analysis shall be considered the chemical analysis for products supplied under this specification.

6.3 When requested by the purchaser at the time of purchase the manufacturer shall report the values of the interstitial elements carbon, oxygen, hydrogen, and nitrogen as specified in Table 2 for each lot of finished product.

7. Mechanical Properties

7.1 *Tensile*—The tensile properties of the finished tube material shall conform to the requirements of Table 3.

7.2 *Flare*—A section of the finished tube shall be capable of being flared without cracking visibly to the unaided eye. The flare shall be made with a tool having a 60° included angle until the outside diameter has been increased 20 %.

7.3 *Reverse Flattening*—A section of welded tube that is slit longitudinally 90° either side of the weld shall be opened and flattened with the weld at the point of maximum bend. No cracking is permitted.

7.4 One set of these mechanical tests shall be made on each lot of tubes and for each fifty process length tubes of each lot or fraction thereof.

[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.

TABLE 1 Ingot Chemical Requirements

Element	(Composition, max weight %)				
	R05200	R05400	R05252	R05255	R05240
O	0.015	0.030	0.015	0.015	0.020
N	0.010	0.010	0.010	0.010	0.010
C	0.010	0.010	0.010	0.010	0.010
H	0.0015	0.0015	0.0015	0.0015	0.0015
Nb	0.10	0.10	0.50	0.10	35.0–42.0
Mo	0.020	0.020	0.020	0.020	0.020
W	0.050	0.050	2.0–3.5	9.0–11.0	0.050
Ti	0.010	0.010	0.010	0.010	0.010
Si	0.005	0.005	0.005	0.005	0.005
Fe	0.010	0.010	0.010	0.010	0.010
Ni	0.010	0.010	0.010	0.010	0.010
Ta	remainder	remainder	remainder	remainder	remainder

TABLE 2 Mechanical Requirements

	R05200/R05400	R05252	R05255	R05240
Ultimate tensile strength, min, psi (MPa)	30 000 (207)	40 000 (276)	70 000 (481)	40 000 (226)
Yield strength, 0.2 % offset, min, psi (MPa)	20 000 (138)	28 000 (193)	60 000 (414)	28 000 (193)
Elongation, min %, in 1 or 2 in. (25 or 51 mm)	25	20	15	20

TABLE 3 Permissible Variations in Outside Dimensions Based on Individual Measurements

Outside Diameter, in. (mm)	Diameter Tolerance,[A,B] Plus or Minus, in. (mm)	Permissible Variations[C] in Wall Thickness, %
Under 1 (25.4), excl	0.004 (0.102)	10
1 to 1½ (25.4 to 38.1), excl	0.005 (0.127)	10
1½ to 2 (38.1 to 50.8), excl	0.006 (0.152)	10
2 to 2½ (50.8 to 63.5), excl	0.007 (0.178)	10
2½ to 3½ (63.5 to 88.9), excl	0.010 (0.254)	10

[A] These permissible variations in outside diameter apply only to tubes as finished at the mill before subsequent swaging, expanding, bending, polishing, or other fabricating operation.

[B] Ovality is the maximum and minimum outside diameter of a tube measured at any one cross section. If the measurement is made with a ring gage the following formula shall apply: Ovality = specified OD tube + diameter tolerance + 0.002 in. (length of ring gage, 1 in.) × nominal diameter.

[C] When minimum wall tubes are ordered, tolerances are all plus and shall be double the values shown.

8. Nondestructive Test Requirements

8.1 *Hydrostatic Test*—If specified in the purchase order, each tube so tested shall withstand without showing bulges, leaks, or other defects, an internal hydrostatic pressure that will produce in the tube wall a stress of 75 % of the minimum specified yield strength at room temperature. This pressure shall be determined by the equation:

$$P = 2\,St/D \quad (1)$$

where:

P = minimum hydrostatic pressure, psi (or MPa),
S = allowable fiber stress of 75 % of the minimum yield strength, psi (or MPa),
t = average wall thickness of the tube, in. (or mm), and
D = outside diameter of the tube in. (or mm).

Maintain the test pressure for a minimum of 10 s.

8.2 *Pneumatic Test*—If specified in the purchase order, each tube so tested shall withstand an internal air pressure of 100 psi (0.7 MPa), minimum for 5 s, minimum without showing evidence of leakage. The test method used shall permit easy visual detection of any leakage such as by placing the tube under water or by using the pressure differential method. Any evidence of the leakage shall be cause of rejection of that tube.

8.3 *Helium Leak Test*—If specified in the purchase order, each tube shall be tested by evacuating to an internal pressure of 10×10^{-6} torr (1.3 MPa) or less and tested for leakage by spraying helium along the length of the outside surface. Detection of a leak at a rate greater than 10×10^{-7} standard cm^3/s shall be cause of rejection of that tube.

8.4 *Ultrasonic Test*—If specified on the purchase order, each length of tube shall be tested ultrasonically. The test procedure and calibration standards shall be agreed upon between the manufacturer and purchaser. Any tube showing an indication in excess of that obtained from the calibration standard shall be set aside and be subject to rework, retest, or rejection. A tube thus set aside may be further examined by other methods for confirmation of the presence of a defect with or without rework; such a tube may be determined acceptable if no other evidence for a defect is found. (Rework by weld repair is not permitted.)

9. Permissible Variations

9.1 *Diameter and Wall Thickness*—The permissible variations in diameter and wall thickness of tubes specified in the purchase order shall not exceed those prescribed in Table 3.

9.2 *Length*—When tubing is ordered cut to length, the usable length shall be not less than that specified; but a variation of +⅛ in. (3.2 mm) will be permitted for lengths up to 6 ft (1.8 m). In lengths over 6 ft, a variation of +¼ in. (6.4 mm) will be permitted, unless otherwise specified.

9.3 *Straightness*—The tube shall be free of bends or kinks and the maximum uniform bow shall not exceed values shown in Table 4.

9.4 *Squareness of Cut*—The angle of cut of the end of any tube may depart from square by not more than 0.016 in./in. (mm/mm) of diameter.

TABLE 4 Straightness

Length, ft (m)	Maximum Curvature Depth of Arc
Over 3 to 6 (0.91 to 1.83), incl	⅛ in. (3.2 mm)
Over 6 to 8 (1.83 to 2.44), incl	3⁄16 in. (4.8 mm)
Over 8 to 10 (2.44 to 3.05), incl	¼ in. (6.4 mm)
Over 10 (3.05)	¼ in./any 10 ft (2.1 mm/m)

10. Workmanship, Finish, and Appearance

10.1 The finished tube shall be clean and free of foreign material, shall have smooth ends, free of burrs, and shall be free of injurious external and internal imperfections in accordance with standards of acceptability agreed upon between the manufacturer and the purchaser. Minor defects may be removed provided the dimensional tolerance of Section 9, are not exceeded.

11. Retest

11.1 If any sample or specimen exhibits obvious surface contamination or improper preparation disqualifying it as a truly representative sample, discard it and substitute a new sample or specimen.

11.2 In case of failure, retest two additional specimens. If both specimens conform to this specification, discard the original values and consider the material acceptable.

11.3 If the inspection results of a lot are not in conformance with the requirements of this specification, the lot may be reworked at the option of the manufacturer. A lot shall be acceptable if results of all tests after reworking conform to the specification.

12. Significance of Numerical Limits

12.1 For the purpose of determining compliance with the specified limits of property requirements, an observed value or a calculated value shall be rounded in accordance with the rounding method of Practice E 29.

13. Inspection

13.1 The manufacturer shall inspect the material covered by the specification prior to shipment.

13.2 If so specified on the purchase order, the purchaser or his representative may witness the testing and inspection of the material at the place of manufacture. In such cases, the purchaser shall state in his purchase order which tests he desires to witness. The manufacturer shall give ample notice to the purchaser as to the time and place of the designated test. If the purchaser's representative does not present himself at the agreed-upon time for the testing, and if no new date is agreed upon, the manufacturer shall consider the requirements for purchaser's inspection at the place of manufacturer to be waived. When the inspector representing the purchaser does appear at the appointed time and place, the manufacturer shall afford him all reasonable facilities to see that the material is being furnished in accordance with this specification. This inspection shall be conducted so as not to interfere unnecessarily with production operations.

14. Rejection and Rehearing

14.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

15. Referee

15.1 In the event of disagreement between the manufacturer and the purchaser of the conformance of the material to the requirements of this specification or any special test specified by the purchaser, a mutually acceptable referee shall perform the tests in question. The results of the referee's testing shall be used in determining conformance of the material to this specification.

16. Certification

16.1 When specified in the purchase order or contract, a producer's or supplier's certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

17. Packaging and Package Marking

17.1 Each bundle, box, or carton shall be marked or tagged legibly and conspicuously with the number of this specification, purchase order number, nominal size, and the gross, net, and tare weights.

17.2 All material shall be packed in such a manner as to assure safe delivery to its destination when properly transported by any common carrier.