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Designation: B654/B654M – 04

Standard Specification for Niobium-Hafnium Alloy Foil, Sheet, Strip, and Plate[1]

This standard is issued under the fixed designation B654/B654M; 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 hafnium alloyed niobium foil, sheet, strip, and plate.

1.2 The material covered by this specification is R04295, niobium-base alloy containing approximately 10 % hafnium and 1 % titanium.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.4 *The following safety hazards caveat pertains only to the test methods portion, Section 14, of this specification: This standard does not purport to address all of the safety problems, 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]

B652/B652M Specification for Niobium-Hafnium Alloy Ingots

E8 Test Methods for Tension Testing of Metallic Materials

E21 Test Methods for Elevated Temperature Tension Tests of Metallic Materials

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

3. Terminology

3.1 *Definitions:*

3.1.1 *foil*, *n*—a flat product less than 6 in. [150 mm] wide and less than 0.005 in. [0.13 mm] in thickness.

3.1.2 *lot*, *n*—a lot is defined as that material produced from one ingot and heat-treated at the same conditions.

3.1.3 *plate*, *n*—a flat product 6 in. [150 mm] or more in width and more than 3⁄16 in. [4.8 mm] in thickness.

3.1.4 *sheet*, *n*—a flat product 6 in. [150 mm] or more in width and from 0.005 in. [0.13 mm] to 3⁄16 in. [4.8 mm] in thickness.

3.1.5 *strip*, *n*—a flat product, may be supplied in coil, less than 6 in. [150 mm] wide and from 0.005 in. [0.13 mm] to 3⁄16 in. [4.8 mm] in thickness.

4. Ordering Information

4.1 Orders for material under this specification should include the following information as applicable:

4.1.1 General alloy description (see 1.2) and ASTM designation and year of issue,

4.1.2 Quantity in weight or pieces,

4.1.3 Size, diameter or thickness, width, and length, as applicable,

4.1.4 Chemical Composition (Section 6),

4.1.5 Temper (Section 7),

4.1.6 Mechanical test temperature and limits (Sections 8 and 14),

4.1.7 Permissible dimensional tolerances and weight or quantity variations (see 9.3),

4.1.8 Quality and finish (see 10.2),

4.1.9 Sampling (see 13.2),

[1] This specification is under the jurisdiction of 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.

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4.1.10 Inspection Witnessing (see 15.2),
4.1.11 Certification Requirements (Section 18), and
4.1.12 Packaging (Section 20).

5. Materials and Manufacture

5.1 Materials covered by this specification shall be made from ingots in accordance with Specification B652/B652M.

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

6. Chemical Composition

6.1 The chemical composition of niobium-hafnium alloy ingots and billets for conversion to finished products covered by this specification shall conform to the requirements in Table 1. Analysis for elements, not listed in Table 1 and not normally expected in niobium-hafnium alloy, 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 specified in the purchase order, the manufacturer shall test the product for elements specified in Table 2. The results of the tests shall meet the limits shown in Table 2.

7. Temper Designations

7.1 Unless otherwise stated, the materials supplied under this specification shall be in the annealed condition, defined as at least 90 % recrystallized.

7.2 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.

8. Mechanical Requirements

8.1 Materials in the annealed condition supplied under this specification shall conform to the requirements for mechanical properties as specified in Table 3. Unless otherwise specified in the purchase order, the materials shall conform to the requirements for room temperature mechanical properties. The purchaser may specify elevated temperature mechanical properties at the time of purchase.

TABLE 1 Chemical Requirements for Ingot

Niobium-Hafnium Alloy R04295	
Element	Content, Maximum Weight % (Except Where Otherwise Specified)
Carbon	0.015
Oxygen	0.025
Nitrogen	0.010
Hydrogen	0.0015
Hafnium	9–11
Titanium	0.7–1.3
Zirconium	0.700
Tungsten	0.500
Tantalum	0.500
Niobium by difference	...

TABLE 2 Additional Chemical Requirements for Finished Product

Niobium-Hafnium Alloy R04295	
Element	Content, Maximum Weight %
Oxygen	0.035
Carbon	0.015
Nitrogen	0.010
Hydrogen	0.0015

9. Permissible Variations

9.1 *Dimensional tolerances*—Tolerances on niobium-hafnium alloy products covered by this specification shall be as prescribed in Table 4.

9.2 Flatness tolerance for sheet and plate products supplied under this specification shall be 6 % maximum, as determined by the following equation (see Fig. 1):

$$\text{Flatness, \%} = (H/L) \times 100 \quad (1)$$

where:

H = maximum vertical distance between a flat reference surface and the lower surface of the sheet, and
L = minimum horizontal distance between the highest point on the sheet and the point of contact with a flat reference surface. (The method for taking measurements for calculation of sheet flatness is shown in Fig. 1. However, a value of H less than 1/32 in. [0.8 mm] shall not be cause for rejection.)

9.3 *Quantity or Weight*—For orders up to 100 ft [30 m], the manufacturer may overship by 20 %. For orders up to 1000 lb [450 kg] or 1000 ft [300 m], the manufacturer may overship by 10 %. The permissible overshipment for orders larger than this quantity shall be negotiated at the time of purchase.

10. Quality and Finish

10.1 Niobium-hafnium alloy product shall be free of injurious external and internal imperfections of a nature that will interfere with the purpose for which it was intended. Material may be finished as forged, rolled, extruded, swaged, drawn; in a cleaned, machined, or ground condition. The manufacturer shall be permitted to remove minor surface imperfections provided such removal does not reduce the dimensions below the minimum permitted by the tolerances in accordance with Section 9.

10.2 Test methods for these defects and standards of acceptability shall be as agreed upon between the purchaser and the manufacturer at the time of purchase.

11. Retests

11.1 If any sample or specimen exhibits obvious surface contamination or improper preparation disqualifying it as a truly representative sample, it shall be discarded and a new sample or specimen substituted.

11.2 In case of failure, two additional specimens shall be retested. If both retest specimens conform to this specification, the original values shall be discarded and the material accepted.

11.3 If the results of the tests are not in conformance with the requirements of this specification, the lot may be evaluated

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