



Designation: **B495 – 10 (Reapproved 2017) B495 – 22**

## Standard Specification for Zirconium and Zirconium Alloy Ingots<sup>1</sup>

This standard is issued under the fixed designation B495; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers six grades of zirconium ingots.

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 method portion, Section 10, 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

E114 Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing

E2626 Guide for Spectrometric Analysis of Reactive and Refractory Metals (Withdrawn 2017)<sup>3</sup>

### 3. Terminology

3.1 *Lot Definitions:*

3.1.1 *ingot, n*—a quantity of metal cast into a shape suitable for subsequent processing to various mill products.

### 4. Classification

4.1 The ingots are furnished in ~~six~~nine grades as follows:

4.1.1 *Grade R60700*—Low oxygen unalloyed zirconium.

4.1.2 *Grade R60702*—Unalloyed zirconium.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B10 on Reactive and Refractory Metals and Alloys and is the direct responsibility of Subcommittee B10.02 on Zirconium and Hafnium.

Current edition approved Nov. 1, 2017 April 1, 2022. Published November 2017 April 2022. Originally approved in 1969. Last previous edition approved in 2010 as B495 – 10; B495 – 10 (2017). DOI: 10.1520/B0495-10R17-10.1520/B0495-22.

<sup>2</sup> 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.

<sup>3</sup> The last approved version of this historical standard is referenced on www.astm.org.

4.1.3 *Grade R60703*—Unalloyed zirconium, metallurgical grade.

4.1.4 *Grade R60704*—Zirconium-tin alloy.

4.1.5 *Grade R60705*—Zirconium-niobium alloy.

4.1.6 *Grade R60706*—Zirconium-niobium alloy.

4.1.7 *Grade R61702*—Unalloyed zirconium, casting application.

4.1.8 *Grade R61704*—Zirconium-tin alloy, casting application.

4.1.9 *Grade R61705*—Zirconium-niobium alloy, casting application.

## **5. Ordering Information**

5.1 Orders for materials under this specification shall include the following information:

5.1.1 Quantity (weight),

5.1.2 Name of material (zirconium ingot),

5.1.3 Grade number (Section 4),

5.1.4 ASTM designation and year of issue,

5.1.5 Finish (Section 8), and

5.1.6 Additions to the specification and supplementary requirements, if required.

NOTE 1—A typical ordering description is as follows: 10 000-lb zirconium ingot, machine conditioned, ASTM B495, dated \_\_, Grade R60702.

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## **6. Materials and Manufacture**

6.1 The ingots covered by this specification shall be manufactured by electron beam, vacuum, or inert atmosphere melting in furnaces conventionally used for reactive metals.

## **7. Chemical Composition**

7.1 The material shall conform to the requirements as to chemical composition prescribed in **Table 1**.

7.2 When requested by the purchaser, a check analysis shall be performed for any elements listed in **Table 1**.

7.2.1 The manufacturer's analysis shall be considered as verified if the check analysis confirms the manufacturer's reported values within the tolerances prescribed in **Table 2**.

## **8. Workmanship, Finish, and Appearance**

8.1 Ingots shall be conditioned by machining, grinding, or surface fusion to remove gross surface and subsurface defects detrimental to subsequent fabrication.

8.2 After conditioning has been completed, no abrupt changes in diameter or local depressions that will impair subsequent fabrication shall be permitted. The difference between the maximum and minimum radii of the conditioned ingot shall not exceed 20 % of the maximum radius, except within 6 in. (150 mm) of the ends of the ingot where rounding is permissible. Lands, grooves,

**TABLE 1 Chemical Requirements<sup>A</sup>**

| Element                  | Composition, %        |         |        |              |            |            |
|--------------------------|-----------------------|---------|--------|--------------|------------|------------|
|                          | UNS Grade Designation |         |        |              |            |            |
|                          | R60700                | R60702  | R60703 | R60704       | R60705     | R60706     |
| Zirconium + hafnium, min | 99.2                  | 99.2    | 98.0   | 97.5         | 95.5       | 95.5       |
| Hafnium, max             | 4.5                   | 4.5     | 4.5    | 4.5          | 4.5        | 4.5        |
| Iron + chromium          | 0.2 max               | 0.2 max | ...    | 0.2 to 0.4   | 0.2 max    | 0.2 max    |
| Tin                      | ...                   | ...     | ...    | 1.00 to 2.00 | ...        | ...        |
| Hydrogen, max            | 0.004                 | 0.004   | ...    | 0.005        | 0.005      | 0.005      |
| Nitrogen, max            | 0.020                 | 0.020   | ...    | 0.025        | 0.025      | 0.025      |
| Carbon, max              | 0.05                  | 0.05    | ...    | 0.05         | 0.05       | 0.05       |
| Niobium                  | ...                   | ...     | ...    | ...          | 2.0 to 3.0 | 2.0 to 3.0 |
| Oxygen, max              | 0.10                  | 0.16    | ...    | 0.18         | 0.18       | 0.16       |

**TABLE 1 Chemical Requirements<sup>A</sup>**

| Element                  | Composition, %        |         |        |              |            |            |         |            |            |  |
|--------------------------|-----------------------|---------|--------|--------------|------------|------------|---------|------------|------------|--|
|                          | UNS Grade Designation |         |        |              |            |            |         |            |            |  |
|                          | R60700                | R60702  | R60703 | R60704       | R60705     | R60706     | R61702  | R61704     | R61705     |  |
| Zirconium + hafnium, min | 99.2                  | 99.2    | 98.0   | 97.5         | 95.5       | 95.5       | 98.8    | 97.1       | 95.1       |  |
| Hafnium, max             | 4.5                   | 4.5     | 4.5    | 4.5          | 4.5        | 4.5        | 4.5     | 4.5        | 4.5        |  |
| Iron + chromium          | 0.2 max               | 0.2 max | ...    | 0.2 to 0.4   | 0.2 max    | 0.2 max    | 0.3 max | 0.3 max    | 0.3 max    |  |
| Tin                      | ...                   | ...     | ...    | 1.00 to 2.00 | ...        | ...        | ...     | 1.0 to 2.0 | ...        |  |
| Hydrogen, max            | 0.004                 | 0.004   | ...    | 0.005        | 0.005      | 0.005      | 0.005   | 0.005      | 0.005      |  |
| Nitrogen, max            | 0.020                 | 0.020   | ...    | 0.025        | 0.025      | 0.025      | 0.03    | 0.03       | 0.03       |  |
| Carbon, max              | 0.05                  | 0.05    | ...    | 0.05         | 0.05       | 0.05       | 0.1     | 0.1        | 0.1        |  |
| Niobium                  | ...                   | ...     | ...    | ...          | 2.0 to 3.0 | 2.0 to 3.0 | ...     | ...        | 2.0 to 3.0 |  |
| Phosphorus, max          | ...                   | ...     | ...    | ...          | ...        | ...        | 0.01    | 0.01       | 0.01       |  |
| Oxygen, max              | 0.10                  | 0.16    | ...    | 0.18         | 0.18       | 0.16       | 0.25    | 0.3        | 0.3        |  |

<sup>A</sup> By agreement between the purchaser and the manufacturer, analysis may be acquired and limits established for elements and compounds not specified in the table of chemical compositions.

**TABLE 2 Permissible Variation in Check Analysis Between Different Laboratories**

| Element         | Permissible Variation in Check Analysis, % |
|-----------------|--|
| Hydrogen        | 0.005                                      |
| Nitrogen        | 0.01                                       |
| Carbon          | 0.02                                       |
| Hafnium         | 0.1  |
| Iron + chromium | 0.03                                       |
| Tin             | 0.05                                       |
| Niobium         | 0.05                                       |
| Oxygen          | 0.02                                       |

and local depressions shall be blended to a maximum angle of 30° to the axis of the ingot. Each end of the ingot shall be chamfered or radiused. The minimum chamfer or radius shall be ½ in. (12 mm).

## 9. Number of Tests and Retests

9.1 At least one sample from the top, middle, and bottom of each ingot shall be analyzed chemically.

9.2 An ultrasonic test shall be conducted on each ingot.

### 9.3 Retests:

9.3.1 If any sample or specimen exhibits obvious contamination, improper preparation, or flaws disqualifying it as a representative sample, it should be discarded and a new sample or specimen substituted.