Designation: B603 – 07 (Reapproved 2013)

# Standard Specification for Drawn or Rolled Iron-Chromium-Aluminum Alloys for Electrical Heating Elements[1]

This standard is issued under the fixed designation B603; 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 annealed, drawn, or rolled shapes for electrical heating and resistance purposes of alloys consisting mainly of iron, chromium, and aluminum as detailed in Table 1.

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 *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 become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, 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]

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

B63 Test Method for Resistivity of Metallically Conducting Resistance and Contact Materials

B70 Test Method for Change of Resistance With Temperature of Metallic Materials for Electrical Heating

B78 Test Method of Accelerated Life of Iron-Chromium-Aluminum Alloys for Electrical Heating

## 3. Terminology

3.1 *Definitions:*

3.1.1 *lot size, n*—the lot size for determining compliance with the requirements of this specification shall be one heat.

## 4. Significance and Use

4.1 This specification on iron-chromium-aluminum alloys contains the requirements for chemistry, electrical resistance, mechanical properties, resistance change with temperature, and packaging.

4.2 Determination of properties is not required for routine acceptance of material unless specified by the purchaser.

## 5. Chemical Requirements

5.1 The alloys shall conform to the requirements as to chemical composition prescribed in Table 1.

5.2 *Samples for Chemical Analysis*—Specimens for chemical analysis may be taken either from the melt or from a sample of finished material that is representative of the lot.

5.3 *Chemical Analysis*—The chemical analysis shall be made in accordance with accepted practices. See Test Methods A751.

## 6. Physical Requirements

6.1 The material shall be thoroughly and uniformly annealed.

6.2 Wire shall conform to the following elongation requirements:

| Size | Elongation in 10-in. (250-mm) minimum, % |
|---|---|
| 0.0035 in. (No. 39 Awg)(0.089 mm) and larger | 12 |
| 0.0031 to 0.0020 in. (Nos. 40 to 44 Awg) (0.079 to 0.015 mm) | 6 |

## 7. Nominal Resistivity

7.1 The nominal resistivity shall be the resistivity of the wire as quenched from a temperature above 1450°F (788°C). The numerical values of the resistivity range at 77°F (25°C) shall be as shown in Table 1.

## 8. Test for Resistivity

8.1 The resistivity shall be determined in accordance with Test Method B63.

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.10 on Thermostat Metals and Electrical Resistance Heating Materials.

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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 Chemical Requirements**

| Class | Resistivity Range | | Composition Range, % | |
|---|---|---|---|---|
| | Ω·cmil/ft | μΩ·cm | Al | Cr |
| I | 825 to 920 | 135 to 150 | 5.00 to 6.00 | 20 to 24 |
| IIA | 795 to 880 | 130 to 144 | 4.75 to 5.75 | 20 to 24 |
| IIB | 770 to 855 | 130 to 144 | 4.00 to 5.25 | 20 to 24 |
| III | 715 to 785 | 119 to 130 | 3.75 to 4.75 | 13 to 16 |
| IV | 665 to 735 | 111 to 122 | 2.75 to 3.75 | 12 to 15 |

## 9. Nominal Electrical Resistance for Unit Length

9.1 The nominal resistance per unit length for round wire shall be calculated from the nominal resistivities and the nominal cross-sectional area.

NOTE 1—Actual values of resistivity and resistance change with temperature have not been tabulated as they vary considerably with minor composition differences. Individual manufacturers should be contacted for detailed information regarding their properties.

NOTE 2—When ribbon or flat wire is produced by rolling from round wire, the cross section departs from that of a true rectangle by an amount depending on the width-to-thickness ratio and the specific manufacturing practice. The conventional formula for computing ohms per foot and feet per pound is to consider the cross section as 17 % less than a true rectangle when a width is more than 15 times the thickness and 6 % less than a true rectangle in other cases. This is not valid in view of modern rolling equipment and practices, but still is widely used as a basis of description. Ribbon actually is made to a specified resistance per foot, and no tolerance is specified for thickness. An alternative and a closer approximation would be that for ribbon rolled from round wire, the electrical resistance would be calculated on a cross 6 % less than a true rectangle.

## 10. Tolerance on Electrical Resistance per Unit Length

10.1 The actual resistance per unit length shall not vary from the nominal resistance by more than the amounts shown in Table 2.

NOTE 3—Tolerances on dimensions are not specified since the material is used for resistance purposes in which the resistivity and the electrical resistance per unit length rather than the dimensions are of prime importance. The electrical resistance per unit length can be determined more accurately than the dimensions of very small sizes on wire or strip.

## 11. Resistance Change with Temperature

11.1 The change in resistance with change in temperature shall be measured in accordance with Test Method B70.

**TABLE 2 Electrical Resistance Tolerance**

| | Resistance Tolerance, % |
|---|---|
| Round Wire: | |
| 0.0050-in. (0.127-mm) diameter and larger | ±5 |
| Finer than 0.0050 to 0.0020-in. (0.127 to 0.051-mm) diameter, incl | ±8 |
| Finer than 0.0020-in. (0.051-mm) diameter | ±10 |
| Strip: | |
| Cold rolled | ±5 |
| Hot rolled | ±8 |

## 12. Accelerated Life Test

12.1 When it is desired to determine the durability of the material at high temperatures, life tests shall be made in accordance with Test Method B78. Test results may be reported either in hours or in percentage of an accepted standard.

12.2 The life or durability value shall be the average of three simultaneous determinations each, on wire specimens of the materials and on the reference standard.

## 13. Finish

13.1 The material shall be as uniform and free from surface defects such as splinters, cracks, splits, kinks, laminations, scale, and other irregularities as the best commercial practice will permit. The finish shall be either bright annealed or oxidized, as specified.

## 14. Packing and Marking

14.1 Packing shall be subject to agreement between the manufacturer and the purchaser.

14.2 The material as furnished under this specification shall be identified by the name or symbol and color code of the manufacturer and by melt number. The lot size for determining compliance with the requirements of this specification shall be one heat.

## 15. Keywords

15.1 electrical heating; heating elements; iron-chromium-aluminum; resistance alloys; resistors