



Designation: F 29 – 97 (Reapproved 2002)

## Standard Specification for Dumet Wire for Glass-to-Metal Seal Applications<sup>1</sup>

This standard is issued under the fixed designation F 29; 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 round, copper-coated 42 % nickel-iron wire, commonly known as dumet, intended primarily for sealing to soft glass.

1.2 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

B 170 Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes<sup>2</sup>

D 1535 Test Method for Specifying Color by the Munsell System<sup>3</sup>

D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials<sup>3</sup>

E 3 Methods of Preparation of Metallographic Specimens<sup>4</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>

E 53 Methods for Chemical Analysis of Copper<sup>6</sup>

E 228 Test Methods for Linear Thermal Expansion of Solid Materials With a Vitreous Silicon Dilatometer<sup>5</sup>

F 14 Practice for Making and Testing Reference Glass-Metal Bead-Seal<sup>7</sup>

### 3. Ordering Information

3.1 The wire is usually supplied with a surface coating consisting of a mixture of copper oxides and fused sodium tetraborate (borax) which retards oxidation of the wire during sealing in glass and further aids wetting of the wire by the

glass. The composite wire may also be purchased as bare wire for specific applications.

3.2 The size of the wire, if applicable, the borate color range designated as light, medium (regular), or dark, shall be specified on each purchase order.

3.3 Package sizes shall be agreed upon between the purchaser and the seller.

### 4. Chemical Composition

4.1 The copper used in the manufacture of dumet shall be 99.90 % minimum copper. Silver shall be included with the copper. The material shall be free of reducible oxides.

4.2 The chemical composition of the nickel-iron core shall be as shown in Table 1.

### 5. Oxide Coating

5.1 The primary standards for the entire range of colors are divided into three groups covering light, medium (regular), and dark as shown, with their respective limits, in Fig. 1 and Table 2 (Note 1). The color range of the specimens shall be determined in accordance with 9.2.

NOTE 1—Color chip 2.5R 3.90/8.0 may be included in the dark range merely to extend the color series for assisting the viewer in making a better decision regarding the cut-off point between medium (regular) and dark dumet.

### 6. Thermal Expansion

6.1 The nominal values for the average coefficient of linear thermal expansion shall be as follows when determined in accordance with 9.1:

6.1.1 *Core*— $63$  to  $72 \times 10^{-7}$  in./in.·deg °C (mm/mm·deg °C) over the temperature range of 30 to 400°C.

TABLE 1 Chemical Requirements: Core Material

Element	Composition, %
Nickel	41 to 43
Manganese	0.75 to 1.25
Silicon, max	0.30
Carbon, max	0.10
Sulfur, max	0.02
Phosphorus, max	0.02
Iron (by difference)	remainder

<sup>1</sup> This specification is under the jurisdiction of ASTM-Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials.

Current edition approved Dec. 10, 1997. Published March 1998. Originally published as F29 – 63 T. Last previous edition F29 – 78 (1991).

<sup>2</sup> Annual Book of ASTM Standards, Vol 02.01.

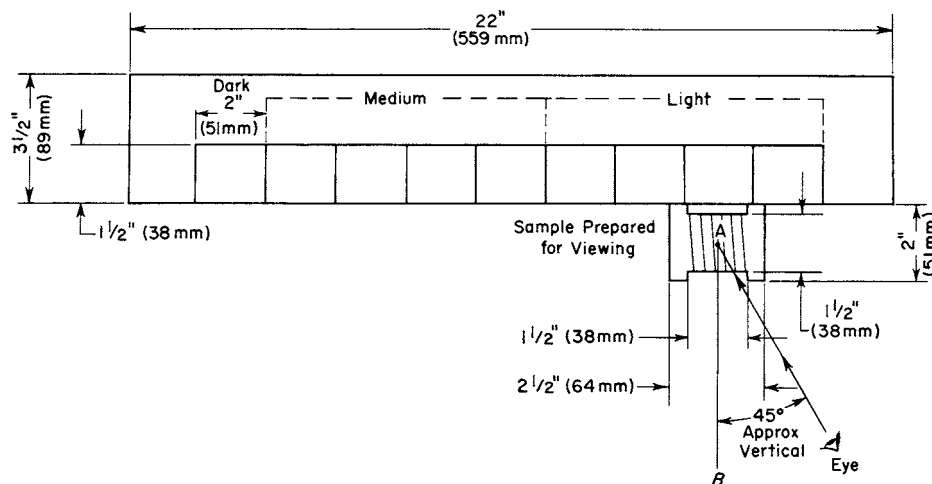
<sup>3</sup> Annual Book of ASTM Standards, Vol 06.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>6</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>7</sup> Annual Book of ASTM Standards, Vol 15.02.



NOTE 1—Wire winding shall be in the same plane as shown and the specimen in the same plane as the color chips. The specimen shall be viewed along direction AB at an inclined angle as illustrated.

FIG. 1 Arrangement of Color Chips for Specimen Comparison

TABLE 2 Color Ranges and Limits

Dark Range	Medium (Regular) Range	Light Range
Colors darker than chip 3.5R 3.94/8.0	3.5R 3.94/8.0 to 6.5R 4.06/8.0, incl	7.5R 4.22/8.0 to 0.5YR 4.56/8.0 incl

6.1.2 Copper— $177 \pm 3.5 \times 10^{-7}$  in./in.·°C (mm/mm-deg °C) over the temperature range of 30 to 300°C.

## 7. Dimensional Tolerances

7.1 The specified diameters shall conform to the tolerances given in Table 3.

## 8. Workmanship and Finish

8.1 *Internal Condition*—The internal structure of the composite material, including the bond area, shall be sound and free from pipes, porosity, or discontinuities which might prevent the making of a satisfactory seal.

### 8.2 Surface Condition:

8.2.1 There shall be no areas of exposed core evident on the surface of the wire.

8.2.2 The wire shall contain no longitudinal scratches, folds, or lines of a depth greater than the width.

8.2.3 There shall be no oil, grease, or other surface contaminants on the wire.

8.2.4 The wire shall be looped or coiled over a mandrel five times the diameter of the wire. At least 75 % of the dumet area shall be free from defects consisting of damaged borate, exposing the copper, when observed at 10× magnification.

TABLE 3 Dimensional Tolerances

Diameter, in. (mm)	Tolerance, in. (mm)
0.007 to 0.013 (0.18 to 0.33)	±0.0003 (±0.008)
Over 0.013 to 0.018 (0.33 to 0.46)	±0.0004 (±0.010)
Over 0.018 (0.46)	±0.0005 (±0.013)

8.2.5 The nickel-iron core shall be uniformly covered with 18 % to 28 % copper (by weight) and the ratio of maximum to minimum sheath thickness shall not exceed 2.5 to 1 on any cross section.

NOTE 2—The sheath is defined as that area exclusive of the core.

8.3 *Storage*—Finished material should be stored in a container or room with a maximum relative humidity of 50 %.

## 9. Test Methods

9.1 *Thermal Expansion*—Determine the thermal expansion characteristics in accordance with Test Method E 228, except that the specimen shall be preheated as follows:

9.1.1 Heat the core rod specimen in a hydrogen atmosphere for 1 h at 900°C; then cool it from 900 to 200°C at a rate not exceeding 5°C/min.

9.1.2 Determine the thermal expansion characteristics in accordance with Test Method E 228.

9.2 *Color of Coating*—Mount the color chips<sup>8</sup> on a neutral background (middle gray to white) as shown in Fig. 1. Wind the specimen to be tested or compared on a flat surface similar to that shown in Fig. 1. Each turn of the wire should lie parallel and as close as possible to the preceding turn without overlapping. View the specimen in natural or artificial daylight in accordance with either or both Method D 1535, (Note 3) or Test Method D 1729 Fig. 2.

NOTE 3—Coated wire carries a mixture of copper oxides and fused sodium tetraborate on the surface of the dumet, which dissolves, wholly or in part, into the glass during the sealing operation. The sealing technique is influenced by the amount of coating, and color has been established as a means of estimating the thickness of this mixture. The color varies from a dark red-purple to a light yellow-red as the thickness decreases. The

<sup>8</sup> The sole source of supply of the color standards known to the committee at this time is the Munsell Color Company, Inc., 2441 N. Calvert St., Baltimore, MD 21218. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee<sup>11</sup>, which you may attend.