



# 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 (ε) 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.

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<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.

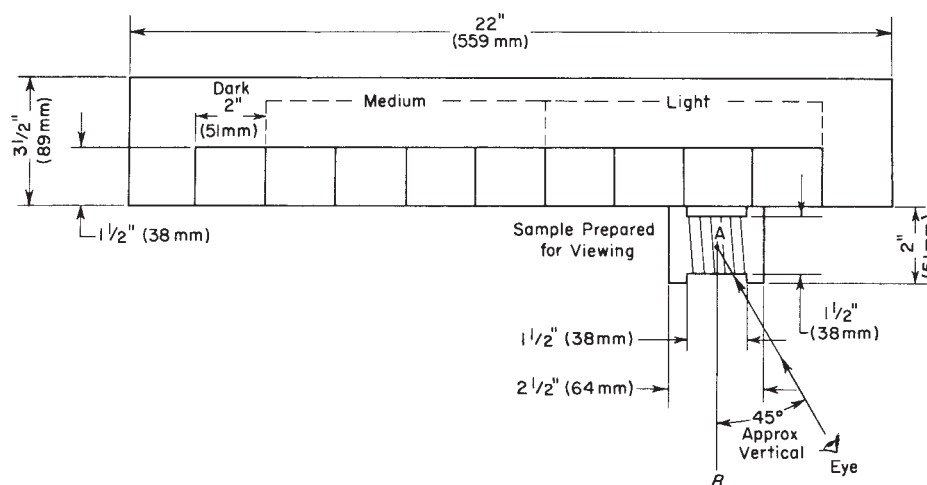
<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

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

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

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



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:

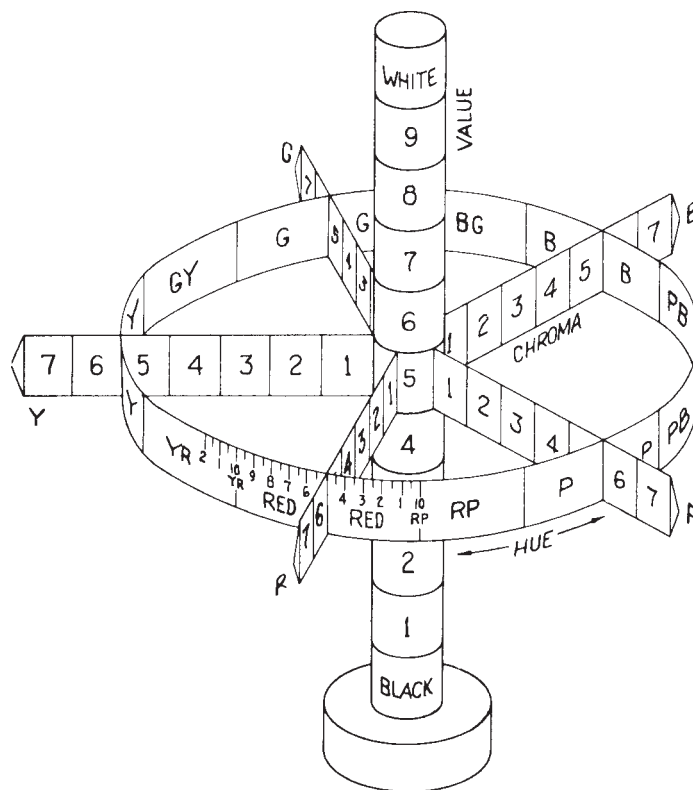
9.1.1 Heat the core rod specimen in a hydrogen atmosphere for 1 h at 900°C; then cool it from 900 to 200°C at a rate not exceeding 5°C/min.

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 1729Fig. 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.



NOTE 1—The circular band represents the hues in their proper sequence. The upright center axis is the scale of value. The paths pointing outward from the center show the steps of chroma, increasing in strength as indicated by the numerals.

FIG. 2 Hue, Value, and Chroma in Their Relationship to One Another

method, described in Test Method D 1535, is based on the color-perception attributes of hue, lightness, and saturation and is used as the means for specifying color. This method employs the Munsell color-notation system in which visual scales are assigned to each of the color-perception attributes. In this system, the attributes are called hue, *H*, value, *V*, and chroma, *C*, written in the form *H V/C*. By using a combination of numbers and letters, apparent color may be exactly specified. The dimensions of the surface-color-perception solid are illustrated in Fig. 2.

9.3 *Diameter*—The diameter of the wire in coils shall be measured at each end. When wire is spooled, approximately 6 ft (1.8 m) shall be unreel and the diameter of the wire measured between the second and sixth foot from the end. The average of the measurements obtained on any coil or spool shall be within the limits specified in Section 7.

9.4 *Reducible Oxides*—Copper shall be tested for reducible oxides in accordance with the methods described in Specification B 170.

9.5 *Copper Analysis*—Copper shall be analyzed by wet chemical methods in accordance with Methods E 53.

9.6 *Metallographic Test*—The internal structure of the wire shall be checked by standard metallographic methods as described in Method E 3.

## 10. Rejection

10.1 Any spool or coil not conforming to the requirements of this specification may be rejected. If 15 % or more of the spools in any shipment do not conform to the specified requirements, the entire shipment may be rejected.

## 11. Packaging and Marking

11.1 Unless otherwise specified, wire supplied on spools or coils shall be continuous with no joints of any type.

11.2 The wire shall be spooled in such a manner that it can be unwound under reasonable tension without binding or otherwise becoming distorted.

11.3 Each spool or coil shall be marked as to wire size, color, date, net weight, and lot number.

11.4 Containers shall be free from any dirt, dust, oil, or other agents that may contaminate the material.

11.5 Each individual spool shall be packaged in a suitable plastic bag, such as polyethylene.

## 12. Keywords

12.1 gloss-to-metal sealing; iron-nickel/copper composite wire; vacuum electronics

## SUPPLEMENTARY REQUIREMENTS

## SUPPLEMENTARY NOTES

NOTE S1—For the purpose of calculating weights, cross sections, etc., the density of the copper shall be taken as 8.89 g/cm<sup>3</sup> at 20°C and the nickel-iron core as 8.12 g/cm<sup>3</sup> at 20°C.

NOTE S2—Dumet is not generally used in sizes above 0.040 in. (1.0 mm).

NOTE S3—Expansion values have been listed for information purposes only.

NOTE S4—Several references and calculated values indicate the radial expansion of dumet to be  $90 \times 10^{-7}$  in./in.-deg °C (mm/mm-deg °C) over the temperature range of 25 to 400°C.

NOTE S5—This material is intended for average applications. It is

realized that for special cases a more precise definition of requirements may be necessary, but these are subject to individual agreement between the manufacturer and the purchaser.

NOTE S6—Some users may require a metal-to-glass seal test similar to that described in Practice F 14.

NOTE S7—Observed or calculated values obtained from analyses, measurements, or tests shall be rounded off in accordance with the rounding-off method given in Practice E 29. These values shall be rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limit.

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