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Standard Specification for Molybdenum Wire and Rod for Electronic Applications[1]

This standard is issued under the fixed designation F289; 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 two grades of molybdenum wire less than 0.050 in. (1.27 mm) in diameter and one grade of molybdenum rod 1.00 in. (25.4 mm) or less in diameter as follows:

1.1.1 *Grade 1*—Commercially pure molybdenum wire suitable for leads, hooks, supports, heaters, and metal-to-glass seals.

1.1.2 *Grade 2*—Commercially pure molybdenum wire suitable for mandrel either black or cleaned.

1.1.3 *Grade 3*—Commercially pure molybdenum rod suitable for leads, hooks, supports, and metal-to-glass seals.

1.2 The term wire applies to all spooled or coiled material and 0.050 in. (1.3 mm) or less in diameter and to short cut lengths 0.020 in. (0.51 mm) or less in diameter.

1.3 The term rod applies to all material over 0.020 in. (0.51 mm) in diameter, supplied in straight lengths.

1.4 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.

1.5 *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.*

1.6 *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:*[2]

D374 Test Methods for Thickness of Solid Electrical Insulation (Metric) D0374_D0374M

E8 Test Methods for Tension Testing of Metallic Materials [Metric] E0008_E0008M

E315 Test Methods for Chemical Analysis of Molybdenum (Withdrawn 2010)[3]

F16 Test Methods for Measuring Diameter or Thickness of Wire and Ribbon for Electronic Devices and Lamps

F205 Test Method for Measuring Diameter of Fine Wire by Weighing

F219 Test Methods of Testing Fine Round and Flat Wire for Electron Devices and Lamps

2.2 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies) [4]

2.3 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage (Military Agencies) [4]

3. Chemical Composition

3.1 All grades of wire and rod shall be 99.90 % minimum pure molybdenum. The maximum allowable oxygen content shall be 0.007 weight% , while the maximum carbon content shall be 0.03 weight %.

4. Mechanical Properties

4.1 *Tensile Properties:*

4.1.1 The tension test specimens and procedures shall conform to Methods F219 for wire diameter up to and including 0.010 in. (0.25 mm), and Test Methods E8 for all other wire and rod diameters.

[1] This specification is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.03 on Metallic Materials, Wire Bonding, and Flip Chip.

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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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

4.1.2 The tensile requirements of wire in sizes up to and including 0.020 in. (0.51 mm) in diameter shall conform to the requirements of Table 1 and shall be calculated by dividing the breaking load in grams-force by the size of the wire expressed in milligrams per 200 mm.

4.1.3 The tensile requirements of wire in sizes over 0.020 in. (0.51 mm) up to 0.050 in. (1.3 mm) in diameter shall conform to the requirements of Table 2.

4.1.4 The tensile requirements of rod shall be as agreed upon between the purchaser and the supplier.

4.2 *Ductility Properties:*

4.2.1 Wire up to 0.003 in. (0.08 mm) in diameter shall not break when subjected to the test prescribed in 11.4.1.

4.2.2 Wire over 0.003 in. (0.08 mm) up to 0.020 in. (0.51 mm) in diameter shall not break or show cracks under observation through a binocular microscope at 30× when subjected to the test prescribed in 11.4.2.

4.2.3 Wire over 0.020 in. (0.51 mm) in diameter shall not break or show cracks under unaided visual observation when subjected to the test prescribed in 11.4.3.

4.2.4 Rod shall have ductility properties as agreed upon between the purchaser and the supplier.

5. Surface Finish

5.1 Molybdenum wire shall be furnished in the following finishes:

5.1.1 As drawn, black, or

5.1.2 As drawn, cleaned.

5.2 Molybdenum rod shall be furnished in the following finishes:

5.2.1 Black,

5.2.2 Cleaned, or

5.2.3 Centerless ground.

5.3 Surfaces shall be smooth and free of contamination and pernicious surface defects.

6. Dimensional Tolerances

6.1 For wire in diameters up to and including 0.020 in. (0.51 mm) in diameter the tolerance shall be ±5 % of weight per 200 mm. The size of wire shall be uniform for Grades 1 and 3 within 2 weight % as measured at both ends of the wire; and for Grade 2 within 1 weight % within the total length of the wire. The standard size tolerance for wire in a diameter range of 0.020 to 0.030 in. (0.51 to 0.76 mm) is± 3 % by diameter; but such wire can be ordered by any of several weight tolerances (mg/200 mm) as agreed upon between the purchaser and the supplier.

TABLE 2 Tensile Requirement

Wire Diameter, in. (mm)	Minimum Tensile Strength, psi (MPa)	Elongation in 10 in. (250 mm), %	
		Class 1, min	Class 2, max
Over 0.020 (0.51) to 0.050 (1.27)	64 000 (441)	6	6

6.2 For black or cleaned rod in diameters over 0.020 in. (0.51 mm) and wire over 0.030 in. (0.76 mm) the tolerance shall be ±3 % of the specified diameter.

6.3 Out-of-roundness of wire over 0.005 in. (0.13 mm) in diameter and all rod except centerless ground shall be within 4 % of the specified diameter, maximum.

6.4 When centerless ground rod is specified, the diameter shall meet the tolerances shown in Table 3.

7. General Requirements

7.1 The material shall be uniform in composition, cross section, and in structural condition.

7.2 Unless otherwise specified, all material shall be provided in the stress-relief annealed condition (not recrystallized).

8. Straightness

8.1 When ordered as straightened, straightness of wire shall be specified as the radius of curvature or camber of a given length of wire as agreed upon between the purchaser and the supplier.

8.2 Rod and short cut lengths shall be straight to within ⅛ in. camber in 1 ft (or 3 mm camber in 300 mm) of length.

NOTE 1—The straightness criterion in terms of maximum permissible camber in an arbitrary length, L', is calculated as the product of the known maximum permissible camber in a specified length, L, and the square of the ratio of L' to L. As an example, consider L' to be 3 ft. In inch-pound units, the maximum camber per 3-ft length = (⅛ in.) $(\frac{3}{1})^2$ = 1⅛ in. In SI units, the maximum camber per 760-mm length = (3 mm) $(\frac{914}{300})^2$ = 28 mm. The relation given constitutes an approximation valid for the purpose as long as L' is not too large; the exact solution can be obtained by considering a circle with the camber in length L' as one segment of a diametral chord perpendicularly bisecting a chord of length L'.

9. Coiling and Spooling

9.1 The spools or bands shall be clean and free of seams or projections that might catch or tangle the wire during unwinding. The wire shall be in one continuous length and wound smoothly in layers, with no piling upon turns, so that it unwinds freely without forming kinks. Inner and outer ends

TABLE 1 Tensile Requirements

Wire Size, mg/200 mm	Maximum Diameter, [A] in. (mm)	Minimum Tensile Breaking Load, gf/(mg/200 mm)	Elongation in 10 in. (250 mm), %	
			Grade 1	Grade 2
Up to 4.11, incl	0.0020 (0.051)	50	>6	≤6
Over 4.11 to 6.42, incl	0.0025 (0.064)	46	>6	≤6
Over 6.42 to 10.53, incl	0.0032 (0.081)	44	>6	≤6
Over 10.53 to 411.2, incl	0.020 (0.51)	40	>6	≤6

[A] Wire diameter, in. = $9.86 \times 10^{-4}\sqrt{\text{weight in mg/200 mm.}}$