Designation: F73 – 96 (Reapproved 2017)

Standard Specification for Tungsten-Rhenium Alloy Wire for Electron Devices and Lamps[1]

This standard is issued under the fixed designation F73; 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 tungsten-rhenium alloy wire suitable for use in electron devices and lamps. The material is known as UNS R07031.

1.2 The term *wire* as used in this specification applies to all material 0.020 in. (0.51 mm) or less in diameter that is spooled or coiled.

1.3 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.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

1.5 *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]

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

3. Ordering Information

3.1 Orders for wire furnished to this specification shall include the following information:

3.1.1 Length in metres,
3.1.2 Name of material,
3.1.3 Straightness (see 6.2),
3.1.4 Finish (see 7.2),
3.1.5 Weight or size (see 6.1) and tolerance, and
3.1.6 Specification number and UNS number.

NOTE 1—A typical ordering description for straight chemically cleaned wire is as follows: xxxx metres tungsten-rhenium alloy wire, straightened, Finish 2; 280.8 mg/200 mm (±3 %), per ASTM F73 – XX (UNS R07031).

4. Chemical Composition

4.1 This wire shall conform to the requirements as to chemical composition prescribed in Table 1.

5. Physical Properties

5.1 *Tensile Strength*—The tensile strength of a 10-in. (250-mm) gage length of wire in grams-force per milligram per 200 mm shall be within the limits prescribed in Table 2, when tested in accordance with 8.2.

5.2 *General Ductility Requirements*—The ductility of wire shall be sufficient to meet the following requirements:

5.2.1 *Wire Sizes up to 75 mg/200 mm, incl*—Six 1-m lengths shall be tested in accordance with 8.3.1. The wire shall not break more than two times in the six tests. Where required, a lower limit may be negotiated between purchaser and seller.

5.2.2 *Wire Sizes over 75 mg/200 mm*—Thirty successive close-wound turns completely around mandrels shall be free from splitting or cracking when tested in accordance with 8.3.2 and examined at a magnification of 30×.

5.3 *Special Ductility Requirements*—Wire for certain applications requires a special ductility as agreed upon between the purchaser and the seller.

6. Size, Straightness, and Tolerances

6.1 Dimensional tolerances for wire for use as incandescent filaments shall conform to the requirements prescribed in Table 3.

NOTE 2—Tolerances are industry standards; closer tolerances may be obtained in certain instances, usually at a premium.

6.2 *Straightness*—Straightness of wire 3.00 mg/200 mm and larger shall be specified as the radius of curvature or camber of

[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.

Current edition approved June 1, 2017. Published June 2017. Originally approved in 1966. Last previous edition approved in 2013 as F73 – 96 (2013). DOI: 10.1520/F0073-96R17.

[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

Element	Composition
Tungsten	remainder
Rhenium, %	2.5 to 3.5
Other elements (each), ppm, max	100
Total other elements, ppm, max	500

TABLE 2 Tensile Properties for UNS R07031

Weight of Wire, mg/200 mm	Tensile Strength, gf/(mg/200 mm)			
	High-Tensile Wire (Finishes 1 and 2)		Medium-Tensile	Wire (Finish 3)
	Min	Max	Min	Max
0.70 to 2.00, incl	85	120	75	105
Over 2.00 to 3.00, incl	75	110	70	100
Over 3.00 to 5.80, incl	65	105	60	100
Over 5.80 to 10.50, incl	75	110	70	100
Over 10.50 to 15.50, incl	70	105	65	95
Over 15.50	65	100	60	90

TABLE 3 Permissible Variations in Weight and Size for All Types of Wire

Weight of Wire, mg/200 mm	Dimensional Tolerances	Size Uniformity End-to-End (Within a Spool)
Up to 0.36	±0.02 mg/200 mm	0.02 mg/200 mm
Over 0.36 to 0.67, incl	±0.03 mg/200 mm	0.02 mg/200 mm
Over 0.67 to 2.0, incl	±3 % by weight	0.02 mg/200 mm
Over 2.0 to 760.0, incl	±3 % by weight	1 %
Over 760.0	±1.5 % of diameter	...

a given length of wire as agreed upon between the purchaser and supplier. For wire under 3.00 mg/200 mm, alternative methods may be used as agreed upon between the purchaser and supplier.

7. Workmanship, Finish, and Appearance

7.1 *General Requirements:*

7.1.1 The material shall be as smooth, as free of twists, bends, curls, kinks, and as free, when examined at 30×, from dents, swaging marks, scratches, swaging die marks, laps, seams, splits, slivers, inclusions, bumps, pits, grooves, cracks, and other physical defects as best commercial practice will permit.

7.1.2 Unless black finish is specified, all types of wire shall be free of graphite, grease, and oil. All finishes shall be as free of dirt, oxide, stains, scale, and other surface defects as best commercial practice permits. Refer to 8.4 for inspection methods.

7.2 *Finish*—The wire shall be furnished in the following finishes:

7.2.1 *Finish 1*—Black,

7.2.2 *Finish 2*—Chemically cleaned,

7.2.3 *Finish 3*—Chemically cleaned and stress relieved,

7.2.4 *Finish 4*—Reducing atmosphere cleaned and annealed, or

7.2.5 *Finish 5*—Etched.

8. Test Methods

8.1 *Chemical Analysis*—Determine gravimetrically or by a combination of spectrochemical and gravimetric analyses.

8.2 *Tensile Strength*—Determine the tensile strength of the wire in accordance with Section 8 of Method F219. Use a flat black background when testing fine wire below 0.005 in. (0.13 mm) in diameter.

8.3 *Ductility*—Determine the ductility of the wire as follows:

8.3.1 *Wire up to 75 mg/200 mm, incl*—Draw the wire over a 90° steel bar edge having a radius approximately equal to the diameter of the wire to be tested. Hold the wire against the edge of the bar with the thumb and draw the wire at an angle of 45° to the bar edge at a rate of approximately 1 m/s until the tension on the wire is sufficient to cause a tight helical coil to be formed after the tension is released (see 5.2.1).

8.3.2 *Wire over 75 mg/200 mm*—Wind 30 successive close-wound turns completely around mandrels of sizes as specified in Table 4 at the recommended forming temperatures. Splitting or cracking indicates failure (see 5.2.2).

8.4 *Visual Inspection*—Check conformance of the wire to the requirements specified in 7.1.2 by visual inspection, except

TABLE 4 Ductility Test Conditions

Wire Diameter, in. (mm)	Mandrel Diameter, in. (mm)	Forming Temperature of Wire, °C
0.0065 to 0.010 (0.17 to 0.25), incl	0.025 (0.64)	400
Over 0.010 to 0.015 (0.25 to 0.38), incl	0.030 (0.76)	500
Over 0.015 to 0.020 (0.38 to 0.51), incl	0.045 (1.14)	600

TABLE 5 Size of Spool, Band, or Coil

Flange or Head Diameter, in. (mm)	Mandrel or Hub Diameter, in. (mm)	Inside or Hole Diameter, in. (mm)	Traverse, in. (mm)
0.715 to 0.785	0.580 to 0.605	0.437 to 0.450	0.420 to 0.430
(18.16 to 19.94)	(14.73 to 15.37)	(11.10 to 11.43)	(10.67 to 10.92)
0.745 to 0.755	0.620 to 0.630	0.250 to 0.260	0.620 to 0.630
(18.92 to 19.18)	(15.75 to 16.00)	(6.35 to 6.60)	(15.75 to 16.00)
1.88 to 2.38	1.13 to 1.63	0.375	0.75 to 1.00
(47.8 to 60.5)	(28.7 to 41.4)	(9.52)	(19.0 to 25.4)
3.50 to 4.63	3.00 to 4.13	0.375	0.625
(88.9 to 117.6)	(76.2 to 104.9)	(9.52)	(15.88)
4.00 to 4.75	3.88 to 4.00	3.50 to 3.88	0.75 to 1.00
(101.6 to 120.6)	(98.6 to 101.6)	(88.9 to 98.6)	(19.0 to 25.4)

that wire used as hooks, supports, springs, anchors, and mesh shall be examined at a magnification of 10×.

8.5 *Dimensional Measurements*—Determine the apparent size and the uniformity of wire up to 760 mg/200 mm in accordance with Test Method F205.

9. Rejection

9.1 Any spool of wire or individual cut pieces not conforming to the specified requirements may be rejected. If 15 % or more of the spools of wire or cut pieces in any shipment do not conform to the specified requirements, the entire shipment may be rejected.

9.2 The purchaser shall return rejected material in a suitable container for shipping, the original if possible, so that it may arrive at the manufacturer's plant in the same condition as it left.

10. Coiling and Spooling

10.1 Spools and bands shall be clean and free from open seams or projections which might catch or tangle the wire during winding.

10.2 Wire shall be furnished in one continuous length and wound smoothly with no loose turns. There shall be no piling up of turns such as to prevent free unwinding or cause kinks or bends when the wire is removed from the spool. The outer end shall be attached firmly to the spool or band by suitable means.

10.3 The size of spool, band, or coil for all sizes of wire shall conform to the requirements specified in Table 5.

10.4 Excepting Finish 5, no spools or bands in any one shipment shall contain less than 100 m of wire for sizes 0.49 mg/200 mm and under; not less than 200 m of wire for sizes 0.50 mg to 50 mg/200 mm inclusive; and not less than 100 m of wire for sizes over 50 to 100 mg/200 mm, inclusive. For wire sizes above 100 mg/200 mm, each spool or band shall contain not less than 50 g of wire.

11. Product Marking

11.1 Each spool or band shall be marked with the following information:

11.1.1 Name of manufacturer,

11.1.2 Wire size in milligrams per 200 mm or the diameter (in inches and millimetres), or both,

11.1.3 Name of material and manufacturer's process designation,

11.1.4 Manufacturer's lot number of material and finishing date,

11.1.5 Quantity in metres, and

11.1.6 Tensile strength of straightened wire.

11.2 Each shipping container shall contain a packing slip plainly marked with the following information:

11.2.1 Purchaser's order number,

11.2.2 Purchaser's specification,

11.2.3 Gross weight and total metres, and

11.2.4 Name of manufacturer.

12. Packaging

12.1 Each shipment shall be packaged in such a manner that it will be protected from injury in transit or in handling. No dusty or linty material shall be used, nor any paperwrapping material containing ingredients that would in any way be injurious to the tungsten.

13. Keywords

13.1 electron devices; tungsten-rhenium alloy; UNS R07031