Designation: F256 – 05(Reapproved 2015)

Standard Specification for Chromium-Iron Sealing Alloys with 18 or 28 Percent Chromium[1]

This standard is issued under the fixed designation F256; 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 chromium-iron alloys, the former, (UNS K91800), nominally 18 % chromium, balance iron, the latter, (UNS K92801), nominally 28 % chromium, in strip, bar, wire, and rod forms intended primarily for sealing to glass in electronic applications.

NOTE 1—UNS K92801 should only be considered for use at service temperatures below 300°C. The alloy is prone to sigma phase formation at temperatures close to 620°C, and exhibits brittle mechanical behavior after prolonged exposures at temperatures close to 475°C.

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 The following hazard caveat pertains only to the test method portion, Sections 16 and 17, of this specification. *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

E3 Guide for Preparation of Metallographic Specimens

E18 Test Methods for Rockwell Hardness of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys

E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer

F14 Practice for Making and Testing Reference Glass-Metal Bead-Seal

F140 Practice for Making Reference Glass-Metal Butt Seals and Testing for Expansion Characteristics by Polarimetric Methods

F144 Practice for Making Reference Glass-Metal Sandwich Seal and Testing for Expansion Characteristics by Polarimetric Methods

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bar:*

3.1.1.1 hot-finished rounds, squares, and hexagons, ¼ in. (6.4 mm) and over in diameter or size.

3.1.1.2 hot-finished flats, ¼ in. to 10 in. (6.4 to 254 mm), inclusive, in width and ⅛ in. (3.2 mm) and over in thickness.

3.1.1.3 cold-finished rounds, squares, octagons, hexagons and shapes, over ½ in. (12.7 mm) in diameter or size.

3.1.1.4 cold-finished flats, ⅜ in. (9.5 mm) and over in width and ⅛ in. (3.2 mm) and over in thickness (see Discussions).

Discussion—Widths less than ⅜ in. (9.5 mm) and thicknesses less than 3⁄16 in. (4.8 mm) are generally described as flat wire.

Discussion—Thicknesses of ⅛ in. (3.2 mm) to under 3⁄16 in. (4.8 mm) can also be described as cold-rolled strip or, if in cut lengths, bar.

3.1.2 *rod*—hot-rolled, or hot-rolled, annealed, and pickled, rounds, squares, octagons, hexagons and shapes, in coils, for subsequent cold drawing or cold rolling, ¼ in. or ¾ in. (6.4 or 19.0 mm) in diameter or size.

3.1.3 *strip*—cold-finished coils or cut lengths, under 24 in. (610 mm) down to and including 3⁄16 in. (4.8 mm) in width, and under 3⁄16 in. down to and including 0.005 in. (0.13 mm) in thickness.

3.1.4 *No. 1 edge*—a rolled edge either round or square as specified.

3.1.5 *No. 3 edge*—an edge produced by slitting.

3.1.6 *No. 5 edge*—an approximately square edge produced by rolling or filing after slitting.

[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.

Discussion—Cold-finished product 0.005 in. (0.13 mm) in thickness and under 24 in. (609.6 mm) in width is sometimes identified as foil.

3.1.7 *wire:*

3.1.7.1 cold finished only, round or square, ½ in. (12.7 mm) and under in diameter or size.

3.1.7.2 cold finished only, flat wire of 1⁄16 in. (1.6 mm) to under 3⁄8 in. (9.5 mm) in width and 0.010 in. (0.25 mm) to under 3⁄16 in. (4.8 mm) in thickness.

4. Classification

4.1 The alloys covered by this specification are classified by nominal chemical composition, specifically by chromium content, in two types:

4.1.1 *Type I*—18 % chromium (UNS K91800) and

4.1.2 *Type II*—28 % chromium (UNS K92801).

5. Ordering Information

5.1 Orders for material under this specification shall include the following information:

5.1.1 Quantity (weight (Note 2) or number of pieces),

5.1.2 Name of material (chromium-iron alloy),

5.1.3 Type (Section 4),

5.1.4 Form (Section 3),

5.1.5 Temper and finish (Section 7),

5.1.6 Permissible variations in dimensions for rod (Section 13),

5.1.7 Certification if required (Section 21),

5.1.8 Packaging required (Section 22),

5.1.9 Dimensions (width, thickness, diameter, etc.),

5.1.10 ASTM designation: F256, and

5.1.11 Exceptions to the specification or special requirements.

NOTE 2—The term "weight" is temporarily used in this standard because of established trade usage. The word is used to mean both "force" and" mass," and care must be taken to determine which is meant in each case (SI unit for force = newton and for mass = kilogram).

5.2 If possible, the intended end use of the item should be given on the purchase order especially when the item is ordered for a specific end use or uses. Such information will enable the manufacturer to produce a material more satisfactory for the purchaser's process and product.

NOTE 3—A typical ordering description is as follows: 2000 kg, chromium-iron alloy. Type II, wire, annealed, cold drawn, commercial packaging, ¼ in. (6.4 mm) round by coil, ASTM F256, end use-redraw.

6. Process

6.1 The purchaser shall specify that the alloy be made by one or more of the following processes: electric-arc, electric-induction, or other process approved by the purchaser.

7. Temper and Finish

7.1 The desired temper of the material shall be specified on the purchase order as follows:

7.1.1 Annealed for forming (strip),

7.1.2 Annealed for deep drawing (strip),

7.1.3 Cold rolled or cold drawn to a specified mechanical property level, or

7.1.4 As hot rolled.

7.2 The desired surface of the material shall be specified on the purchase order as follows:

7.2.1 Pickled,

7.2.2 Cold drawn (wire and bar),

7.2.3 Centerless ground (wire and bar), or

7.2.4 Cold rolled (strip).

8. Chemical Composition

8.1 The material shall conform to the chemical composition specified in Table 1.

TABLE 1 Chemical Requirements

NOTE 1—Round observed or calculated values to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of Practice E29.

Element	Composition, %	
	Type I	Type II
Carbon, max	0.08	0.12
Manganese, max	1.00	1.00
Silicon, max	0.75	0.75
Phosphorus, max	0.040	0.040
Sulfur, max	0.030	0.030
Chromium, nominal	18.0	28.0
Nickel, max	0.50	0.50
Nitrogen, max	...	0.20
Titanium	[A]	...
Iron	remainder	remainder

[A] Five times the carbon content, minimum, and 0.60, max.

8.2 *Ladle Analysis*—A ladle analysis of each heat of steel shall be made by the manufacturer to determine the percentages of the elements specified in Table 1. The analysis shall be made from test castings made during the pouring of the heat. The chemical composition thus determined shall conform to the requirements specified in Table 1.

8.3 *Check Analysis*—If check analysis is made by the purchaser, the chemical composition thus determined shall conform to the requirements specified in Table 1 subject to the permissible tolerances of Table 2.

TABLE 2 Check Analysis Tolerances

Element	Tolerances over maximum or under minimum limits, percentage points
Carbon	0.01
Manganese	0.03
Phosphorus	0.005
Sulfur	0.005
Silicon	0.05
Nickel	0.03
Nitrogen	0.01
Titanium	0.05

9. Chemical Analysis

9.1 Chemical analysis shall be made in accordance with Method E38 or equivalent methods.

10. Thermal Expansion Requirements

10.1 The material shall conform to the thermal expansion requirements prescribed in Table 3.

TABLE 3 Thermal Expansion Requirements[A,B]

Temperature Range,° C	Mean Coefficient of Linear Thermal Expansion, µm/m ·°C	
	UNS K91800	UNS K92801
30 to 530	11.3 to 11.7	10.8 to 11.4

[A]Typical thermal expansion data for the alloys covered by this specification are given for information only in the Appendix.
[B]These requirements apply to specimens heat treated prior to test in accordance with Section 16.

11. Mechanical Property Requirements

11.1 The material shall conform to the mechanical property requirements prescribed in Table 4. Rockwell hardness shall be determined in accordance with Test Method E18.

TABLE 4 Mechanical Property Requirements[A]

Thickness, in. (mm)	Rockwell Hardness (or equivalent) (max)	Tensile Strength, max.	
		ksi	MPa
Under 0.015 (0.38)	...	85	590
0.015 (0.38) to 1 (25.4), incl	B85	...	...
Over 1 (25.4)	B88	...	...

[A]Applicable to strip in the annealed condition only. All other mechanical properties as agreed upon between purchaser and manufacturer.

12. Transformation Requirements

12.1 The material shall show no evidence of transformation to martensite. For Type I alloy, the austenite formed during heat treating will transform to martensite at or above room temperature. The presence of austenite, as may be noted in Type II alloy, is acceptable if the thermal expansion requirement is met.

13. Permissible Variations in Dimensions

13.1 Material furnished under this specification, except rod, shall conform to the dimensional requirements of Tables 5-15.

13.2 Permissible variations in dimensions for rod for redrawing or rerolling shall be as agreed upon between purchaser and manufacturer.

14. Workmanship, Finish, and Appearance

14.1 The material shall be commercially smooth and uniform in cross section, composition, and temper; it shall be free of scale corrosion, cracks, seams, scratches, slivers, processing lubricants, and other defects as best commercial practice will permit.

15. Number of Tests and Retests

15.1 Test specimens for thermal expansion and phase-transformation requirements shall be selected on the basis of a minimum of one specimen per heat.

TABLE 5 Permissible Variations in Size of Cold-Finished Round Bars

Specified Size, in. (mm)	Permissible Variations from Specified Size, in. (mm) [A,B]	
	Over	Under
Over ½ (12.7) to 1 (25.4), excl	0.002 (0.05)	0.002 (0.05)
1 (25.4) to 1½ (38.1), excl	0.0025 (0.064)	0.0025 (0.064)
1½ (38.1) to 4 (101.6), incl [C]	0.003 (0.08)	0.003 (0.08)

[A] Unless otherwise specified, size tolerances are over and under as shown in the above table. When required, however, they may be specified all over and nothing under, or all under and nothing over, or any combination of over and under, if the total spread in size tolerance for a specified size is not less than the total spread shown in the table.
[B] When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.
[C] Cold-finished bars over 4 in. (101.6 mm) in diameter are produced; size tolerances for such bars have not been evolved.

TABLE 6 Permissible Variations in Length of Hot-Finished or Cold-Finished Bars [A]

Specified Size of Rounds, Squares, Hexagons, Octagons, and Widths of Flats, in. (mm) [B]	Permissible Variations in Length, in. (mm)			
	For Lengths up to 12 ft (3.7 m), incl		For Lengths over 12 ft (3.7 m), to 25 ft (7.6 m), incl	
	Over	Under	Over	Under
To 2 (50.8), incl	½ (12.7)	0	¾ (19.0)	0
Over 2 (50.8) to 4 (101.6), incl	¾ (19.0)	0	1 (25)	0
Over 4 (101.6) to 6 (152.4), incl	1 (25)	0	1¼ (32)	0
Over 6 (152.4) to 9 (228.6), incl	1¼ (32)	0	1½ (38)	0
Over 9 (228.6) to 12 (304.8), incl	1½ (38)	0	2 (51)	0

[A]The order should specify random lengths or specific lengths. When random lengths are ordered, the length tolerance is not less than 2 ft (609.6 mm). When specific lengths are ordered, Table 8 or Table 9 shall apply.
[B]The maximum width of bar flats is 10 in. (254.0 mm).

15.2 Test specimens for mechanical properties shall be selected on the basis of a minimum of one specimen per size, each heat, each lot annealed or otherwise heat treated under the same conditions, and each lot with like processing.

15.3 If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

15.4 If the results of any test lot are not in conformance with the requirements of this specification, such lots may be retreated at the option of the manufacturer. The material shall be acceptable if the results of tests on the retreated material are within the requirements of this specification.

16. Specimen Heat Treatment

16.1 The specimens for thermal-expansion and phase-transformation tests shall be heat treated prior to testing as follows:

16.1.1 *Type I*—Heat the specimen to 1200 ± 10°C and hold at temperature for 15 min. Air cool to room temperature.

16.1.2 *Type II*—Heat the specimen to 1100 ± 10°C and hold at temperature for 15 min. Air cool to room temperature. The cooling rate is recommended to be faster than 300°C per hour between 600 and 300°C. Slower cooling rates could lead to brittle mechanical behavior.