



Designation: F31 – 16

Standard Specification for Nickel-Chromium-Iron Sealing Alloys¹

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1. Scope

1.1 This specification covers two iron-nickel-chromium alloys (UNS K94760 and UNS K95150) used primarily for glass-sealing applications in electronic devices.

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 *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

E18 Test Methods for Rockwell Hardness of Metallic Materials

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

E112 Test Methods for Determining Average Grain Size

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

E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

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

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. Ordering Information

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

3.1.1 Size,

3.1.2 Temper (Section 6),

3.1.3 Surface finish (Section 8),

3.1.4 Marking and packaging (Section 13), and

3.1.5 Certification if required.

4. Chemical Composition

4.1 The material shall conform to the requirements of **Table 1** as to chemical composition.

NOTE 1—The major constituents of this alloy may be adjusted by the manufacturer so that the alloy meets the requirement for thermal expansion.

5. Chemical Analysis

5.1 Chemical analysis shall be made, when desired, in accordance with Test Methods **E354**.

6. Surface Lubricants

6.1 All lubricants used during cold-working operations such as drawing, rolling, or spinning, shall be capable of being removed readily by any of the common organic degreasing solvents.

7. Temper

7.1 The desired temper of the material shall be specified on the purchase order. Unless otherwise specified, wire, rod, and tubing shall be given a final bright anneal by the manufacturer. Strip and sheet shall be annealed properly to develop drawing properties. For deep drawing, the hardness shall not exceed Rockwell B90 when determined in accordance with Test Methods **E18**.

8. Grain Size

8.1 Strip and sheet for deep drawing applications shall have an average grain size not larger than ASTM No. 5 (**Note 2**), with no more than 10 % of the grains larger than No. 5 when measured in accordance with Test Methods **E112**. For materials less than 0.005 in. (0.13 mm) in thickness, the grain size shall be such that there are no less than 4 grains across the thickness.

NOTE 2—This corresponds to a grain size finer than 0.065 mm or 16

TABLE 1 Chemical Composition

| Element | 42Ni-6Cr(UNS K94760) Composition, % | 47Ni-6Cr(UNS K95150) Composition, % |
|-------------------|--|--|
| Nickel, nominal | 42.0 | 47.0 |
| Chromium, nominal | 5.6 | 6.0 |
| Carbon, max | 0.07 | 0.02 |
| Manganese, max | 0.25 | 0.30 |
| Phosphorus, max | 0.025 | 0.025 |
| Sulfur, max | 0.025 | 0.025 |
| Silicon, max | 0.30 | 0.30 |
| Aluminum, max | 0.20 | - |
| Iron | remainder | remainder |

grains/in.² of image at 100x.

9. Dimensional Tolerances

9.1 *Cold-Rolled Strip*—Cold-rolled strip shall conform to the permissible variations in dimensions prescribed in [Table 2](#), [Table 3](#), and [Table 4](#).

9.2 *Round Wire and Rod*—Wire and rod shall conform to the permissible variations in dimension prescribed in [Table 5](#).

9.3 *Cold-Drawn Tubing*—Cold-drawn tubing, available either as seamless or welded, shall conform to the permissible variations prescribed in [Table 6](#).

10. Surface Finish

10.1 The standard surface finishes available shall be those resulting from the following operations:

10.1.1 Hot rolling,

10.1.2 Forging,

10.1.3 Centerless grinding (rod),

10.1.4 Belt polishing,

10.1.5 Cold rolling, and drawing, and

10.1.6 Wire drawing.

10.2 Care shall be taken to prevent the depletion of surface chromium during processing.

11. Thermal Expansion Characteristics

11.1 The average linear coefficient of thermal expansion shall be within limits specified in [Table 7](#).

12. Test Method for Thermal Expansion

12.1 Heat the specimen for 15 min at 1100°C in a hydrogen or cracked-ammonia atmosphere with a dew point of –40°C and cool to room temperature at a rate not exceeding 5°C/min.

12.2 Determine the thermal expansion characteristics in accordance with Test Method [E228](#).

12.3 The thermal expansion match between the alloy and a glass may be evaluated by preparing and testing an assembly in accordance with Practice [F14](#), Practice [F140](#), or Practice [F144](#).

13. Test Results

13.1 Observed or calculated values obtained from analysis, measurements, or tests shall be rounded off in accordance with the rounding-off method of Practice [E29](#), to the nearest unit in the last right-hand place of figures used in expressing the specified limit.

TABLE 2 Permissible Variations in Thickness of Cold-Rolled Strip

NOTE 1— Measurement shall be made at least 3/8 in. (9.5 mm) from the edge of strip over 1-in. (25.4 mm) wide.

| Specified Thickness | | Permissible Variations in Thickness for Width Given, ± | | | | | | | |
|-----------------------|------------------|--|---------------|-----------------|----------------|------------------|-----------------|-------------------|-----------------|
| in. | (mm) | Under 3 in. | (Under 76 mm) | Over 3 to 6 in. | (76 to 150 mm) | Over 6 to 12 in. | (150 to 300 mm) | Over 12 to 16 in. | (300 to 400 mm) |
| 0.160 to 0.100, incl | (4.06 to 2.54) | 0.002 | (0.05) | 0.003 | (0.076) | 0.004 | (0.10) | 0.004 | (0.10) |
| 0.099 to 0.069, incl | (2.51 to 1.75) | 0.002 | (0.05) | 0.003 | (0.076) | 0.003 | (0.076) | 0.004 | (0.10) |
| 0.068 to 0.050, incl | (1.73 to 1.27) | 0.002 | (0.05) | 0.003 | (0.076) | 0.003 | (0.076) | 0.003 | (0.076) |
| 0.049 to 0.035, incl | (1.24 to 0.89) | 0.002 | (0.05) | 0.0025 | (0.064) | 0.003 | (0.076) | 0.003 | (0.076) |
| 0.034 to 0.029, incl | (0.86 to 0.74) | 0.0015 | (0.038) | 0.002 | (0.05) | 0.0025 | (0.064) | 0.0025 | (0.064) |
| 0.028 to 0.026, incl | (0.71 to 0.66) | 0.0015 | (0.038) | 0.0015 | (0.038) | 0.002 | (0.05) | 0.002 | (0.05) |
| 0.025 to 0.020, incl | (0.64 to 0.51) | 0.001 | (0.025) | 0.0015 | (0.038) | 0.002 | (0.05) | 0.002 | (0.05) |
| 0.019 to 0.017, incl | (0.48 to 0.43) | 0.001 | (0.025) | 0.001 | (0.025) | 0.0015 | (0.038) | 0.002 | (0.05) |
| 0.016 to 0.012, incl | (0.41 to 0.30) | 0.001 | (0.025) | 0.001 | (0.025) | 0.0015 | (0.038) | 0.0015 | (0.038) |
| 0.011 to 0.0101, incl | (0.28 to 0.256) | 0.001 | (0.025) | 0.001 | (0.025) | 0.001 | (0.025) | 0.0015 | (0.038) |
| 0.010 to 0.0091, incl | (0.254 to 0.231) | 0.001 | (0.025) | 0.001 | (0.025) | 0.001 | (0.025) | 0.001 | (0.025) |
| 0.009 to 0.006, incl | (0.228 to 0.152) | 0.00075 | (0.019) | 0.00075 | (0.019) | ... | ... | ... | ... |
| Under 0.006 | (0.152) | 0.0005 | (0.013) | 0.0005 | (0.013) | ... | ... | ... | ... |