



Designation: F 2229 – 02

Standard Specification for Wrought, Nitrogen Strengthened 23Manganese- 21Chromium-1Molybdenum Low-Nickel Stainless Steel Alloy Bar and Wire for Surgical Implants (UNS S29108)¹

This standard is issued under the fixed designation F 2229; 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 the chemical, mechanical, and metallurgical requirements for wrought nitrogen strengthened 23manganese-21chromium-1molybdenum low-nickel stainless steel alloy bar and wire for surgical implants.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents of the inch-pound units may be approximate.

2. Referenced Documents

2.1 ASTM Standards:

- A 262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels²
- A 484 Specification for General Requirements for Stainless Bars, Billets, and Forgings²
- A 555 Specification for General Requirements for Stainless Steel Wire and Wire Rods²
- A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products²
- E 8 Test Methods for Tension Testing of Metallic Materials³
- E 10 Test Methods for Brinell Hardness of Metallic Materials³
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials³
- E 45 Test Methods for Determining the Inclusion Content of Steel³
- E 112 Test Methods for Determining Average Grain Size³
- E 354 Test Methods for Chemical Analysis of High Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys⁴
- F 138 Specification for Wrought 18Chromium-14Nickel-2.5Molybdenum Stainless Steel Bar and Wire for Surgical Implants (UNS S31673)⁵

F 746 Test Method for Pitting and Crevice Corrosion of Metallic Surgical Implant Materials⁵

F 748 Practice for Selecting Generic Biological Test Methods for Materials and Devices⁵

F 1314 Specification for Wrought Nitrogen Strengthened 22Chromium-12.5Nickel-5Manganese-2.5Molybdenum stainless Steel Bar and Wire for Surgical Implants (UNS S20910)⁵

F 1586 Specification for Wrought Nitrogen Strengthened 21Chromium-10Nickel-3Manganese-2.5Molybdenum Stainless Steel Bar for Surgical Implants (UNS S31675)⁵

2.2 Aerospace Material Specification:

AMS 2248 Chemical Check Analysis Limits, Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys⁶

2.3 ISO Standard:

ISO 6892 Metallic Materials Tensile Testing at Ambient Temperature⁷

2.4 American Society for Quality Standard:

ASQ C1 Specification of General Requirements for a Quality Program⁸

3. General Requirements for Delivery

3.1 In addition to the requirements of this specification, all requirements of the current editions of Specifications A 484 and A 555 shall apply.

3.2 In cases where a conflict exists between this specification and the standards listed in Section 2, this specification shall take precedence.

4. Ordering Information

4.1 Inquiries and orders for material under this specification shall include the following information:

4.1.1 Quantity,

4.1.2 ASTM designation and date of issue,

¹ This specification is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.12 on Metallurgical Materials.

Current edition approved Dec. 10, 2002. Published February 2003.

² Annual Book of ASTM Standards, Vol 01.03.

³ Annual Book of ASTM Standards, Vol 03.01.

⁴ Annual Book of ASTM Standards, Vol 03.05.

⁵ Annual Book of ASTM Standards, Vol 13.01.

⁶ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

⁷ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

⁸ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203.



- 4.1.3 Mechanical properties,
- 4.1.4 Form,
- 4.1.5 Applicable dimensions including size, thickness, width, and length (exact, random, or multiples) or drawing number,
- 4.1.6 Condition,
- 4.1.7 Special tests, if any, and
- 4.1.8 Other requirements.

5. Materials and Manufacture

5.1 *Condition*—Bar and wire shall be furnished, as specified, in the annealed or cold-worked condition. Bar used for the production of forgings may be furnished in the hot worked condition, as agreed upon between purchaser and supplier.

5.2 *Finish*—Types of finish available in bar and wire are cold-drawn, pickled, ground, ground and polished, or as specified by the purchaser.

6. Chemical Requirements

6.1 The supplier's heat analysis shall conform to the chemical requirements prescribed in Table 1. The supplier shall not ship material that is outside the limits specified in Table 1.

6.1.1 Requirements for the major and minor elemental constituents are listed in Table 1. Also listed are important residual elements. Analysis for elements not listed in Table 1 is not required to verify compliance with this specification.

6.1.2 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods A 751.

6.1.3 For reference purposes, Test Methods E 354 shall apply.

6.2 *Product Analysis*—The product analysis is either for the purpose of verifying the composition of a heat or lot or to determine variations in the composition within the heat.

6.2.1 Acceptance or rejection of a heat or lot of material may be made by the purchaser on the basis of this product analysis.

6.2.2 Product analysis tolerances do not broaden the specified heat analysis requirements but cover variations between laboratories in the measurement of chemical content. Product analysis limits shall be as specified in Table 2.

TABLE 1 Chemical Composition

Element	Composition, % (mass/mass)
Carbon	0.08 max
Manganese	21.00 to 24.00
Phosphorus	0.03 max
Sulfur	0.01 max
Silicon	0.75 max
Chromium	19.00 to 23.00
Nickel	0.05 max
Molybdenum	0.50 to 1.50
Nitrogen	0.85 to 1.10
Copper	0.25 max
Iron	balance ^A

^A Approximately equal to the difference of 100 % and the sum percentage of the other specified elements. The percentage of iron difference is not required to be reported.

TABLE 2 Product Analysis Tolerances^A

Element	Permissible Variation Under the Minimum Limit or Over the Maximum Limit, % (mass/mass) ^B
Carbon	0.01
Manganese ^C	0.20
Phosphorus	0.005
Sulfur	0.005
Silicon	0.05
Chromium	0.25
Nickel	0.03
Molybdenum	0.05
Nitrogen ^C	0.05
Copper	0.03

^A Refer to AMS 2248 for chemical check analysis limits (except nitrogen).

^B For elements in which only a maximum percentage is indicated, the "under minimum limit" is not applicable.

^C The specified range for this element is not covered by AMS 2248 and has been established through industrial practice.

7. Metallurgical Requirements

7.1 The material shall exhibit no delta ferrite phase when it is examined metallographically at 100× magnification.

7.2 The microcleanliness of the steel, as determined by Practice E 45, Method A, on representative billet or bar samples from the heat shall not exceed the following:

Inclusion Type	A (Sulphide)	B (Alumina)	C (Silicate)	D (Globular oxide)
Thin	1.5	2.5	2.5	2.5
Heavy	1.5	1.5	1.5	1.5

7.3 The surface of products supplied with a machined or ground surface finish shall have no free ferrite when optically examined at a magnification of 100×.

8. Mechanical Requirements

8.1 Tensile Properties:

8.1.1 Tensile properties shall be determined in accordance with Test Methods E 8.

8.1.2 The mechanical properties of test specimens shall conform to the requirements specified in Table 3.

8.2 Hardness:

8.2.1 Hardness values shall be determined in accordance with Test Methods E 10 or Test Methods E 18.

8.2.2 When desired, hardness limits may be specified by the purchaser. Hardness determinations shall be made on a product cross section, midway between the center and surface, if cross section is adequate.

TABLE 3 Mechanical Requirements

Condition	Ultimate Tensile Strength min, psi (MPa)	Yield Strength (0.2 % offset), min, psi (MPa)	Elongation ^A min, %	Reduction in Area min, %
Annealed	120 000	75 000	30	50
Condition A (827)		(517)		
Cold Worked	150 000	120 000	20	50
Condition B (1034)		(827)		
Cold Worked	200 000	180 000	12	40
Condition C (1379)		(1241)		

^A Elongation of material 0.063 in. (1.6 mm) or greater in diameter (D) or width (W) shall be measured using a gage length of 2 in. or 4D or 4W. The gage length must be reported with the test results. The method for determining elongation of material under 0.063 in. (1.6 mm) in diameter or thickness may be negotiated. Alternatively, a gage length corresponding to ISO 6892 may be used when agreed upon between supplier and purchaser ($5.65 \times S_o^{1/2}$, where S_o is the original cross sectional area of the gage length).

