



Designation: **F2229—07 F2229 – 12**

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

This standard is issued under the fixed designation F2229; 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 ( $\epsilon$ ) 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 either SI units or inch-pound units are to be regarded separately as the standard. The SI equivalents of the inch-pound units may be approximate standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

[A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels](#)

[A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings](#)

[A555/A555M Specification for General Requirements for Stainless Steel Wire and Wire Rods](#)

[A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products](#)

[E8E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E10 Test Method for Brinell Hardness of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E45 Test Methods for Determining the Inclusion Content of Steel](#)

[E112 Test Methods for Determining Average Grain Size](#)

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

[E407 Practice for Microetching Metals and Alloys](#)

[F138 Specification for Wrought 18Chromium-14Nickel-2.5Molybdenum Stainless Steel Bar and Wire for Surgical Implants \(UNS S31673\)](#)

[F746 Test Method for Pitting or Crevice Corrosion of Metallic Surgical Implant Materials](#)

[F748 Practice for Selecting Generic Biological Test Methods for Materials and Devices](#)

[F1314 Specification for Wrought Nitrogen Strengthened 22 Chromium – 13 Nickel – 5 Manganese – 2.5 Molybdenum Stainless Steel Alloy Bar and Wire for Surgical Implants \(UNS S20910\)](#)

[F1586 Specification for Wrought Nitrogen Strengthened 21Chromium—10Nickel—3Manganese—2.5Molybdenum Stainless Steel Alloy Bar for Surgical Implants \(UNS S31675\)](#)

[IEEE/ASTM SI 10 American National Standard for Metric Practice](#)

#### 2.2 Aerospace Material Specification:<sup>3</sup>

[AMS 2248 Chemical Check Analysis Limits, Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys](#)

<sup>1</sup> 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 Aug. 1, 2007; Oct. 1, 2012. Published August 2007; October 2012. Originally approved in 2002. Last previous edition approved in 2002 as F2229—02; F2229 – 07. DOI: 10.1520/F2229-07-10.1520/F2229-12.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

\*A Summary of Changes section appears at the end of this standard

[AMS 2630 Inspection, Ultrasonic Product over 0.5 Inch \(12.7 mm\) Thick](#)

2.3 *ISO Standards*:<sup>4</sup>

[ISO 6892 Metallic Materials Tensile Testing at Ambient Temperature](#)

[ISO 9001 Quality Management Systems—Requirements](#)

2.4 *American Society for Quality Standard*:<sup>5</sup>

[ASQ C1 Specification of General Requirements for a Quality Program](#)

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *bar*—round bar and flats from 0.1875 in. (~~4.75 mm~~)[4.75 mm] to 4.00 in. (~~101.60 mm~~)[101.60 mm] in diameter or thickness (other sizes and shaped by special order).

3.1.2 *forging bar*—as described in section 3.1.1 used for the production of forgings, may be furnished in the hot rolled condition.

3.1.3 *lot*—the total number of mill products produced from the same melt heat under the same conditions at essentially the same time.

3.1.4 *wire*—rounds less than 0.1875 in. (~~4.75 mm~~)[4.75 mm] in diameter.

### 4. Ordering Information

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

4.1.1 ~~Quantity~~; Quantity;

4.1.2 ASTM designation and date of ~~issue~~; issue;

4.1.3 Mechanical ~~properties~~; properties;

4.1.4 ~~Form~~; Form;

4.1.5 Applicable dimensions including size, thickness, width, and length (exact, random, or multiples) or drawing ~~number~~; number;

4.1.6 *Tolerances*—Unless otherwise specified by purchaser, tolerances must meet the requirements of Specifications [A484/A484M](#) and/or [A555/A555M](#), as ~~applicable~~; applicable;

4.1.7 Condition (see 5.1);;

4.1.8 Finish (see 5.2);;

4.1.9 Special tests, if ~~any~~; any; and

4.1.10 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 the 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

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

**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 <sup>A</sup>

<sup>A</sup> Approximately equal to the difference of 100 % and the sum percentage of the other specified elements. Reporting the percentage of iron difference is not required.

material with a composition outside the requirements 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 **A751**.

6.2 *Product Analysis*—The product analysis is either for the purpose of verifying the composition of a heat or manufacturing 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**.

6.2.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods **E354**.

## 7. Metallurgical Requirements

7.1 The material shall contain no delta ferrite, chi, or sigma phases when it is examined metallographically at 100× magnification in accordance with Practice **E407**.

7.2 The microcleanliness of the steel, as determined by Practice **E45**, Method A, except using plate I-r, 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 **E8E8/E8M**.

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 **E10** or Test Methods **E18**.

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 the cross section is adequate.

8.3 *Number of Tests:*

8.3.1 Perform tension testing per Test Methods **E8E8/E8M**. Should any of the test specimens not meet the specified requirements, test two additional test pieces representative of the same lot, in the same manner, for each failed test piece. The lot shall be considered in compliance only if all additional test pieces meet the specified requirements.

**TABLE 2 Product Analysis Tolerances<sup>A</sup>**

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

<sup>A</sup> Refer to AMS 2248 for chemical check analysis limits (except nitrogen).

<sup>B</sup> For elements in which only a maximum percentage is indicated, the “under minimum limit” is not applicable.

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