



Designation: F799 – 06

Standard Specification for Cobalt-28Chromium-6Molybdenum Alloy Forgings for Surgical Implants (UNS R31537, R31538, R31539)¹

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1. Scope*

1.1 This specification covers requirements of cobalt-28chromium-6molybdenum alloy (UNS R31537, R31538, R31539) high-strength forgings for the manufacture of surgical implants. The properties specified in this document specifically apply to finished or semifinished parts that receive no subsequent thermomechanical processing.

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 Wrought material to be used as forging stock in the manufacture of forgings conforming to this specification, typically hot worked and unannealed with a surface finish suitable for forging, shall be fabricated and supplied in accordance with F1537.

2. Referenced Documents

2.1 *ASTM Standards*:²

- E8 Test Methods for Tension Testing 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
- E112 Test Methods for Determining Average Grain Size
- E165 Practice for Liquid Penetrant Examination for General Industry
- E930 Test Methods for Estimating the Largest Grain Observed in a Metallographic Section (ALA Grain Size)
- F75 Specification for Cobalt-28 Chromium-6 Molybdenum Alloy Castings and Casting Alloy for Surgical Implants (UNS R30075)
- F601 Practice for Fluorescent Penetrant Inspection of Me-

tallic Surgical Implants

F981 Practice for Assessment of Compatibility of Biomaterials for Surgical Implants with Respect to Effect of Materials on Muscle and Bone

F1537 Specification for Wrought Cobalt-28Chromium-6Molybdenum Alloys for Surgical Implants (UNS R31537, UNS R31538, and UNS R31539)

2.2 *ISO Standards*:³

ISO 6892 Metallic Materials—Tensile Testing at Ambient Temperature

ISO 9001 Quality Management Systems—Requirements

2.3 *American Society for Quality Standard*:⁴

ASQ C1 Specification of General Requirements for a Quality Program

3. Terminology

3.1 *Definitions of Terms Specific to This Standard*:

3.1.1 *lot, n*—the total number of forgings produced from the same heat of starting material under the same conditions at essentially the same time.

4. Ordering Information

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

- 4.1.1 Quantity, number of pieces
- 4.1.2 ASTM designation, date of issue, and alloy number,
- 4.1.3 Condition,
- 4.1.4 Mechanical properties,
- 4.1.5 Finish,
- 4.1.6 Applicable dimensions or drawing number,
- 4.1.7 Special tests, if any, and
- 4.1.8 Other requirements.

5. Materials and Manufacture

5.1 Materials for forgings shall be bar, rod, or wire fabricated in accordance with Specification F1537.

5.2 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting, and shall be processed, if

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

⁴ Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

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

practical, so as to cause metal flow during the hot-working operation to be in the most favorable direction for resisting stresses encountered in service, as may be indicated to the supplier by the purchaser.

5.3 Forgings shall be free of splits, scale, cracks, flaws, and other imperfections not consistent with good commercial practice (see **Note 1**). Offset or mismatch allowance, dependent upon part size and configuration, shall be within standard forging tolerances.

5.4 Optional identification marks, including the purchaser's logo, material designation, heat code number, and impression number, may be placed upon each forging, the method and location of which shall be as specified by the purchaser.

NOTE 1—Compliance to these requirements may be verified by Test Method **E165** or Practice **F601** or other suitable methods.

6. Chemical Requirements

6.1 The cobalt-28chromium-6molybdenum alloy forgings shall conform to the chemical requirements prescribed in Table 1 of Specification **F1537**. The supplier shall not ship material that is outside the limits specified in Table 1 of Specification **F1537** for the applicable alloys. Specification **F1537** contains three alloys:

Alloy 1	Low Carbon (UNS R31537)
Alloy 2	High Carbon (UNS R31538)
Alloy 3	Dispersion Strengthened (UNS R31539)

7. Mechanical Requirements

7.1 Tensile Properties:

7.1.1 Tensile properties shall be determined in accordance with Test Methods **E8**.

7.1.2 The mechanical properties of test specimens prepared from finished or semifinished parts shall conform to the requirements in **Table 1**.

7.1.3 Tension test specimens shall be produced from finished or semifinished parts or from material having the same process history as that which exists in the final forging. Tension specimens may have a ground finish on the reduced section and may be taken in a direction parallel to the long axis of the finished or semifinished part.

7.1.4 A minimum of two tension test specimens shall be tested. Should either of the two specimens not meet the specified requirements, two additional specimens shall be tested and both must pass.

7.1.5 If any fracture takes place outside the middle half of the gauge length or in a punched or scribed gauge mark within the reduced section, the elongation value obtained may not be representative of the material. In acceptance testing, if the elongation so measured meets the minimum requirements specified, no further testing is required, but if the elongation is less than the minimum requirements, discard the test and retest.

7.1.6 In some instances, mechanical test pieces may not be obtainable directly from forged parts due to their configuration or small size. Instead of mechanical testing, these parts shall exhibit hardness of HRC 35 to 45 when tested in accordance with Test Methods **E18**.

7.2 **Hardness**—Forgings conforming to this specification shall have a minimum Rockwell C hardness of 35 HRC. The hardness determination shall be performed in accordance with Test Methods **E18**.

8. Special Tests

8.1 The average grain size of forgings shall be ASTM No. 5 or finer when tested in accordance with Test Methods **E112**. In forgings it may not be possible to fully recrystallize the entire microstructure to a fine grain size. Duplex microstructures exhibiting areas of unrecrystallized grains as large as ASTM No. 2 (or ALA No. 2, as applicable, see Test Method **E930**) shall be acceptable provided a minimum of 50 % of the area of each section examined displays an average grain size of ASTM No. 5 or finer; and the average microhardness of the larger grained regions is the equivalent of HRC 38 or greater. In quantities of 10 % (by area of the metallographic section in question) or less, unrecrystallized grains as large as ASTM No. 0 (or ALA No. 0, as applicable) shall be acceptable provided the average microhardness of the larger grained regions is the equivalent of HRC 40 or greater.

8.2 When specified by the purchaser, fluorescent penetrant inspection shall be performed on forgings. These penetrant inspections shall be performed in accordance with Practices **E165** and **F601**.

9. Significance of Numerical Limits

9.1 The following applies to all specified limits in this specification. To determine conformance to these limits, an observed calculated value shall be rounded to the nearest unit in the last right hand digit used in expressing the specification limit, in accordance with the rounding method of Practice **E29**.

10. Certification

10.1 The supplier shall provide a certification of conformance that the material was tested in accordance with this specification and met all requirements. A report of the test results shall be furnished to the purchaser at the time of shipment.

11. Quality Program Requirements

11.1 The alloy suppliers and any processors shall maintain a quality program as defined in **ASQ C1** or **ISO 9001**.

TABLE 1 Mechanical Requirements

Ultimate Tensile Strength, min, psi, (MPa)	Yield Strength (0.2 % offset), min, psi (MPa)	Elongation, ^A in 2 in. or 4D or 4W, min %	Reduction in Area, min, %	Hardness, HRC, min
170 000 (1172)	120 000 (827)	12	12	35

^A Elongation of material 0.063 in. (1.6 mm) or greater in diameter (D) or width (W) shall be measured using a gauge length of 2 in. or 4D or 4W. The gauge 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. Alternately, a gauge length corresponding to **ISO 6892** may be used when agreed upon between supplier and purchaser. (5.65 square root So, where So is the original cross sectional area.)