



Designation: F 799 – 99

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. Material conforming to this specification has been evaluated for biocompatibility and corrosion resistance² and has been found to be comparable to material conforming to Specification F 75. The properties specified in this document specifically apply to finished or semifinished parts that receive no subsequent metallurgical processing.

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

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 F 1537.

2. Referenced Documents

2.1 ASTM Standards:

- E 8 Test Methods for Tension Testing of Metallic Materials³
- E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials³
- E 112 Test Methods for Determining the Average Grain Size³
- E 165 Test Method for Liquid Penetrant Examination⁴
- E 930 Test Methods for Estimating the Largest Grain Observed in a Metallographic Section (ALA Grain Size)³
- F 75 Specification for Cast Cobalt-Chromium-Molybdenum Alloy for Surgical Implant Applications⁵
- F 601 Practice for Fluorescent Penetrant Inspection of Metallic Surgical Implants⁵

¹ This specification is under the jurisdiction of ASTM Committee F-4 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.12 on Metallurgical Materials.

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² Supporting data are available from ASTM Headquarters, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

³ *Annual Book of ASTM Standards*, Vol 03.01.

⁴ *Annual Book of ASTM Standards*, Vol 03.03.

⁵ *Annual Book of ASTM Standards*, Vol 13.01.

F 981 Practice for Assessment of Compatibility of Biomaterials (Non-porous) for Surgical Implants with Respect to Effect of Materials on Muscle and Bone⁵

F 1537 Specification for Wrought Cobalt-28 Chromium-6 Molybdenum Alloy for Surgical Implants⁵

2.2 *American Society for Quality Standard*.⁶

ASQ C1 Specification of General Requirements for a Quality Program

3. Significance and Use

3.1 The purpose of this specification is to characterize the properties of currently available cobalt-28chromium-6molybdenum forgings.

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,
- 4.1.3 Mechanical properties,
- 4.1.4 Form (semifinished parts, part No.),
- 4.1.5 Applicable dimensions or print number,
- 4.1.6 Condition (forged, heat treated, annealed),
- 4.1.7 Special tests, and
- 4.1.8 Other requirements.

5. Condition

5.1 The material shall be forged by hammering, pressing, rolling, extruding, or upsetting, and shall be processed, if practicable, so as to cause metal flow during the hot-working operation in the direction most favorable for resisting stresses encountered in service, as may be indicated by the implant manufacturer.

5.2 Forgings shall be free of splits, scale, cracks, flaws, and other imperfections not consistent with good commercial practice.

5.3 Optional identification marks, including the manufacturer's logo, material designation, heat code number, and impression number, may be placed upon each forging, the

⁶ Available from American Society for Quality, 161 W. Wisconsin Ave., Milwaukee, WI 53203.

method and location of which shall be as specified by the purchaser.

6. Chemical Composition

6.1 The chemical composition of forgings shall meet the chemical requirements of F 1537

7. Mechanical Requirements

7.1 Tensile Properties:

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

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 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 test specimens shall be tested. If one specimen falls below the specified tensile requirements, two additional specimens shall be tested and both must pass. If a specimen breaks outside the gage, the test is null in accordance with Methods E 8, and a retest should be performed.

7.1.5 In some instances mechanical test pieces may not be obtainable directly from forged parts due to their configuration

or small size. In lieu of mechanical testing, these parts shall exhibit hardness of HRC 35 to 45 when tested in accordance with Test Methods E 18.

7.2 *Hardness*—Finished or semifinished parts 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 E 18.

8. Special Tests

8.1 The grain size of forgings shall be five or finer when tested in accordance with Test Methods E 112. 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 E 930) 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 implant manufacturer, liquid penetrant inspection or fluorescent penetrant inspection shall be performed on forgings. These penetrant inspections shall be performed in accordance with Practices E 165 and F 601.

9. Certification

9.1 The fabricator's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished to the implant manufacturer with each shipment.

TABLE 1 Mechanical Requirements

Ultimate Tensile Strength, min, psi, (MPa)	Yield Strength (0.2 % offset), min, psi (MPa)	Elongation, ^A min, %	Reduction in Area, min, %	Hardness, R_c , min
170 000 (1172)	120 000 (827)	12	12	35

^A Gage length = 4 × diameter.