



Designation: F799 – 19

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

This standard is issued under the fixed designation F799; 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 requirements of cobalt-28 chromium-6 molybdenum 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 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 Specification **F1537**.

1.3 *Units*—The SI units in this standard are the primary units. The values stated in either primary SI units or secondary inch-pound units are to be regarded separately as 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.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

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

**E8/E8M Test Methods for Tension Testing of Metallic Materials**

**E18 Test Methods for Rockwell Hardness of Metallic Materials**

<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.

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<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.

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

**E112 Test Methods for Determining Average Grain Size**

**E165/E165M Practice for Liquid Penetrant Testing 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 Metallic Surgical Implants**

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

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

**IEEE/ASTM SI 10 American National Standard for Use of the International System of Units (SI): The Modern Metric System**

2.2 *ISO Standards*:<sup>3</sup>

**ISO 6892-1 Metallic materials – Tensile testing – Part 1: Method of test at room temperature**

**ISO 9001 Quality management systems – Requirements**

## 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 Units to be certified (SI or inch-pound),

4.1.4 Condition,

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

- 4.1.5 Mechanical properties,
- 4.1.6 Finish,
- 4.1.7 Applicable dimensions or drawing number,
- 4.1.8 Special tests, if any, and
- 4.1.9 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 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 with these requirements may be verified by Practice **E165/E165M** or Practice **F601**, or other suitable methods.

## 6. Chemical Requirements

6.1 The cobalt-28 chromium-6 molybdenum 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/E8M**.

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 semi-finished 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 semi-finished 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. Dimensions and Permissible Variations

### 8.1 Units of Measure:

8.1.1 **Selection**—This specification requires that the purchaser selects the units (SI or inch-pound) to be used for product certification. In the absence of a stated selection of units on the purchase order, this selection may be expressed by the purchaser in several alternate forms listed in order of precedence.

8.1.1.1 If the purchaser and supplier have a history of using specific units, these units shall continue to be certified until expressly changed by the purchaser.

8.1.1.2 In the absence of historic precedence, if the units used to define the product on the purchaser's purchase order, specification, and engineering drawing are consistent, these units shall be used by the supplier for product certification.

8.1.1.3 If the purchaser's selection of units is unclear, the units of measure shall be agreed upon between the purchaser and supplier.

8.1.2 **Conversion of Units**—If the supplier's test equipment does not report in the selected units, the test equipment units may be converted to the selected units for certification purposes. Accurate arithmetic conversion and proper use of significant digits should be observed when performing this conversion. **IEEE/ASTM SI 10** provides guidelines for the use

**TABLE 1 Mechanical Requirements**

Ultimate Tensile Strength, min, MPa (psi)	Yield Strength (0.2 % offset), min, MPa (psi)	Elongation, <sup>4</sup> in 50.8 mm (2 in.) or 4D or 4W, min, %	Reduction in Area, min, %	Hardness, HRC, min
1172 [170 000]	827 (120 000)	12	12	35

<sup>4</sup>Elongation of material 1.575 mm (0.062 in.) or greater in diameter (D) or width (W) shall be measured using a gage length of 50.8 mm (2 in.) or 4D or 4W. The gage length shall be reported with the test results. The method for determining elongation of material under 1.575 mm (0.062 in.) in diameter or thickness may be negotiated. Alternatively, a gage length corresponding to ISO 6892-1 (5.65 times the square root of S<sub>0</sub>, where S<sub>0</sub> is the original cross-sectional area) may be used when agreed upon between the supplier and purchaser.