



Designation: B994/B994M – 22

Standard Specification for Nickel-Cobalt Alloy Coating¹

This standard is issued under the fixed designation B994/B994M; 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 describes the requirements for corrosion-resistant coatings of electrodeposited nickel-cobalt on metallic substrates and electrodeposited nickel-cobalt used for electroforming.

NOTE 1—The nickel-cobalt alloy is principally deposited as a coating on steel products. It can also be electrodeposited on iron, stainless steel, aluminum, titanium, and any other metal substrate.

NOTE 2—The nickel-cobalt alloy coating has a low coefficient of friction of 0.08 that provides a dry lubricant on part surfaces that are in contact with each other and are subject to galling.

1.2 This specification incorporates an accelerated exposure test method to evaluate the effects of corrosion and galling on the coating, and incorporates a means of reporting the results to the purchaser.

1.3 The specification incorporates a classification scheme that establishes service conditions for thickness, classes of deposits based on the level of monitoring, and type based on supplemental coatings used after deposition.

1.4 The coating thickness ranges from 5 to >30 μm , and it can be applied to machined parts, springs, latches, threaded parts, fasteners, etc. The deposit can also be used to electroform parts requiring high strength with the alloy being maintained at 50 % nickel-cobalt.

1.5 The nickel-cobalt alloy is used to protect ferrous metals in contact with corrosive environments such as: oil and gas production facilities, coastal marine, and ACQ (Alkaline Copper Quaternary) treatments for wood treatments.

1.6 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.8 *This standard has been revised to comply with the Restriction of Hazardous Substances **RoHS Requirements** that seek to limit the exposure of workers and the public to toxic metals. The nickel-cobalt alloy does not contain any of the six Restricted Hazardous Substances.*

1.9 *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:²

- A193/A193M Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
- A194/A194M Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- A681 Specification for Tool Steels Alloy
- B117 Practice for Operating Salt Spray (Fog) Apparatus
- B183 Practice for Preparation of Low-Carbon Steel for Electroplating
- B242 Guide for Preparation of High-Carbon Steel for Electroplating
- B254 Practice for Preparation of and Electroplating on Stainless Steel
- B320 Practice for Preparation of Iron Castings for Electroplating
- B322 Guide for Cleaning Metals Prior to Electroplating
- B374 Terminology Relating to Electroplating
- B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
- B571 Practice for Qualitative Adhesion Testing of Metallic Coatings

¹ This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.03 on Engineering Coatings.

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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.

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



B602 Guide for Attribute Sampling of Metallic and Inorganic Coatings
B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
B762 Guide of Variables Sampling of Metallic and Inorganic Coatings
B849 Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement
B850 Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement
D1193 Specification for Reagent Water
E2465 Test Method for Analysis of Ni-Base Alloys by Wavelength Dispersive X-Ray Fluorescence Spectrometry
F519 Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments
F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
G59 Test Method for Conducting Potentiodynamic Polarization Resistance Measurements
G85 Practice for Modified Salt Spray (Fog) Testing
G102 Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements
G193 Terminology and Acronyms Relating to Corrosion
 2.2 *ISO Standard*.³
ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 *Definitions*—Definitions of terms used in this specification are in accordance with Terminologies **B374** and **G193**.

4. Classification

4.1 The coatings of nickel-cobalt have been classified as follows: service condition by thickness and type by secondary treatments.

4.2 *Service Condition (SC)*—This number signifies the thickness requirement based on the type of environment and desired mechanical properties.

NOTE 3—The 50 % NiCo alloy produces a high strength alloy that is used in electroforming to manufacture parts. These deposits can be used at various thicknesses ranging from 1 µm to hundreds of microns.

4.2.1 SC5 signifies that the application is slightly corrosive and that a minimum 5 µm of coating is sufficient for protection and to provide the mechanical properties.

4.2.2 SC12 signifies that the application is mildly corrosive and that a minimum 12 µm of coating is sufficient to protect against corrosion and provide the mechanical properties.

4.2.3 SC18 signifies that the application is corrosive and that a minimum of 18 µm of coating is sufficient to protect against corrosion and provide the mechanical properties.

4.2.4 SC25 signifies that the application is corrosive and that a minimum 25 µm of coating is sufficient to protect against corrosion and provide the mechanical properties.

4.3 *Type*—This number signifies the type of secondary treatment applied after the coating to modify the surface properties.

NOTE 4—The type classification is used to identify supplemental coating that enhances the performance in various applications. For qualification test purposes, if a supplemental coating is not used, that is Type 0. Type 1 supplemental coatings are used to lock the threads or metal-to-metal contact points to increase the amount of energy needed to disassemble the junction. Type 2 supplemental coatings are used to reduce the friction and aid in disassembly. Materials like gold, thallium, and PTFE can be used to provide lubricity and reduce the break torque.

4.3.1 Type 0 coatings are not treated with any supplemental coatings.

4.3.2 Type 1 coatings are treated with a material to secure the coating to itself.

4.3.3 Type 2 coatings are treated with a material to reduce the friction between coated surfaces.

5. Ordering Information

5.1 The purchaser shall specify the following when ordering this coating:

5.1.1 The specification number and revision year,

5.1.2 The service condition, class, and type,

5.1.3 The significant surface on the part as identified on a drawing,

5.1.4 The base metal alloy designation under ASTM standard or equivalent,

5.1.5 The tensile strength of the base metal in MPa,

5.1.6 Any supplemental requirements including Type 1 and Type 2 secondary treatments,

5.1.7 Any exception to stress relief prior to coating (see section 7.3),

5.1.8 Any exceptions to post anneal heat treatments (see section 7.4),

5.1.9 Any exceptions to tests specified in the acceptance tests (see section 8), and

5.1.10 Any exceptions to tests specified in the qualifications tests (see section 9).

5.1.11 Any special requirements of shot peening or location of rack or wire in the coating process, or both, should be specified by the purchaser. Otherwise refer to 7.2.3 and 7.3.

6. Coating Requirements

6.1 The coatings shall be nickel-cobalt alloy produced by electrodeposition.

6.2 The nickel shall be in the range of 43 to 61% and the cobalt shall be in the range of 39 to 57%.

6.3 This coating shall be applied to the significant surface to the desired minimum thickness of the service condition.

6.4 The coating shall meet all applicable requirements as established in the purchase order in accordance with Section 5.

7. Materials and Manufacture

7.1 *Substrate*—Defects in the surface of the basis metal such as scratches, porosity, pits, inclusions, roll and die marks, laps, cracks, burrs, cold shuts, and roughness may adversely affect the appearance and performance of the deposit, despite the observance of the best plating practice. Any such defects on

³ Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, <http://www.iso.org>.