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Standard Specification for Coatings of Cadmium-Zinc Mechanically Deposited[1]

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1. Scope

1.1 *General*—This specification covers the requirements for a coating that is a mixture of cadmium and zinc deposited on metallic products by mechanical deposition. The coating is provided in four thickness classes (see Table 1) and several finish types (see Table 2).

1.2 *Toxicity*—**Warning:** Cadmium is toxic; therefore these coatings should not be used on articles that will contact food or beverages, or for dental and other equipment that may be inserted into the mouth. Also, the coatings should not be used on articles that will be heated to high temperatures, because cadmium will form toxic fumes. Similarly, if coated articles are welded, soldered, or otherwise heated during fabrication, adequate ventilation should be provided to exhaust toxic fumes.

1.3 *Similar Documents*—Other kinds of mechanically deposited coatings are covered by Specifications B635, B695, and B696.

1.4 The following precautionary caveat pertains only to the test method portion, Section 9, of this specification. *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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
B320 Practice for Preparation of Iron Castings for Electroplating
B322 Guide for Cleaning Metals Prior to Electroplating
B374 Terminology Relating to Electroplating
B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section
B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
B571 Practice for Qualitative Adhesion Testing of Metallic Coatings
B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
B635 Specification for Coatings of Cadmium-Tin Mechanically Deposited
B695 Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
B696 Specification for Coatings of Cadmium Mechanically Deposited
B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
B762 Test Method of Variables Sampling of Metallic and Inorganic Coatings
E27 Method for Spectrographic Analysis of Zinc and Zinc Alloys by the Solution-Residue Technique[3]
E396 Test Methods for Chemical Analysis of Cadmium
E536 Test Methods for Chemical Analysis of Zinc and Zinc Alloys
F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

3. Terminology

3.1 *Definitions*—Some of the terms used in this are defined in Terminology B374.

4. Classification

4.1 *Thickness Classes*—The coating is classified in four thickness classes, as defined in Table 1.

4.2 *Coating Types*—The coating is classified by type, as defined in Table 2.

[1] This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatingsand is the direct responsibility of Subcommittee B08.06 on Soft Metals.

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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] Withdrawn.

TABLE 1 Thickness Classes

Class	Coating Thickness Minimum, μm	Typical Applications
7	7	Automotive fasteners
12	12	Increased corrosion resistance (for example, bellville washers)
25	25	Exterior hardware
50	50	Pole line hardware in severe environments

TABLE 2 Coating Types

Type	Description	Typical Applications
I	As-coated, without supplementary treatments.	Lowest cost where white corrosion products are acceptable. For elevated temperature application that will degrade Type II coatings (see 1.2).
IIa	With yellow to bronze color supplementary chromate coating.	Delay the appearance of white corrosion products. Increase total corrosion protection.
IIb	With brown to olive drab color supplementary chromate coating.	Greater corrosion resistances than IIa. To provide a match to military equipment.
IIc	Type IIa, dyed.	Color coding Decorative purposes
IId	Type IIa with an added lubricant or organic finish (oil, wax, lacquer, etc.)	Lubricity Maximum corrosion resistance

5. Ordering Information

5.1 In order to make the application of this specification complete, the purchaser needs to supply the following information to the seller on the purchase order or other governing documents:

5.1.1 The name, designation, and year of issue of this specification,

5.1.2 Thickness class (see 4.1), including a maximum thickness if appropriate,

5.1.3 Coating type (see 4.2), including required color if Type IIc is used, and required lubricant or organic finish if Type IId is used,

5.1.4 Nature of the substrate, for example: high-carbon steel, mild steel, copper, brass:

5.1.4.1 State if precoating stress relief heat treatment is required and the time and temperature to be used if different from the standard values (see section 12.1),

5.1.4.2 State if special pretreatments are required to modify the surface of the article (see Note 1),

5.1.4.3 If special cleaning precautions are to be followed (see A1.1), and

5.1.5 Identification of significant surfaces (see 7.4.2).

5.1.6 Requirements and methods of testing one or more of the following:

5.1.6.1 Need for and type of special test specimens (see 9.1),

5.1.6.2 Appearance (see 7.3),

5.1.6.3 Deposit composition (see 9.2),

5.1.6.4 Thickness (see 9.5),

5.1.6.5 Adhesion (see 9.6),

5.1.6.6 Corrosion resistance (see 9.7),

5.1.6.7 Absence of hydrogen embrittlement, waiting time prior to testing and testing loads (see 9.8), and

5.1.7 The sampling plan to be used (see 8.1) and responsibility for inspection (see section 13.1).

6. Significance and Use

6.1 *Corrosion Resistance, General*—This functional coating is used to provide corrosion resistance. The performance of this coating depends largely on its thickness and the kind of environment to which it is exposed. Published results of environmental corrosion studies have demonstrated that the coating provides corrosion resistance greater than equivalent thicknesses of zinc coatings in industrial environments and greater corrosion resistance than equivalent thicknesses of cadmium coatings in marine environments.[4]

6.2 *Galvanic Corrosion Resistance*—The galvanic couple that results in the corrosion of steel and aluminum parts in contact with each other in corrosive environments can also be minimized by plating the steel parts with this mechanically deposited coating.

6.3 *Hydrogen Embrittlement, Absence of*—The mechanical coating process does not produce any permanent hydrogen embrittlement in products made from high-strength steels, for example, fasteners or lock washers.

7. Coating Requirements

7.1 *Nature of Coating*—The coating shall be a mechanically deposited mixture of cadmium and zinc with the composition 45 to 75 mass % zinc, remainder cadmium.

7.2 *Coating Process:*

7.2.1 *Coating*—The cadmium-zinc coating shall be produced by mechanical deposition in accordance with the process description given in Annex A1.

7.2.2 *Supplementary Treatments*—Type II coatings shall be produced by treatment with acidic solutions that contain hexavalent chromium compounds and anions that act as catalysts or film-forming compounds.

7.3 *Appearance:*

7.3.1 *General*—The coating on all readily visible surfaces shall be uniform in appearance, well compacted, and complete in coverage. Superficial staining from rinsing and drying and mild variations in color and luster are acceptable.

7.3.2 *Surface Defects*—Defects and variations in appearance in the coating that arise from surface conditions of the substrate (scratches, pores, roll marks, inclusions, etc.) and that persist in the coating despite the observance of good metal finishing practices shall not be cause for rejection.

NOTE 1—Coatings generally perform better in service when the substrate over which they are applied is smooth and free of torn metal, inclusions, pores, and other defects. The specifications covering the unfinished products should provide limits for these defects. A metal finisher can often remove defects through special treatments, such as grinding, polishing, abrasive blasting, chemical etches, and electropolishing. However, these are not normal in the treatment steps preceding the

[4] Holford, Raymond N., Jr., "Five Year Outdoor Exposure Corrosion Comparison," Mechanical Finishing, July 1988.

application of the coating. When they are desired, they are the subject of special agreement between the purchaser and the seller.

7.4 *Thickness:*

7.4.1 *Conformance to Specified Class*—The thickness of the coating everywhere on the significant surfaces shall conform to the requirements of the specified class as defined in 4.1.

7.4.2 *Significant Surfaces*—Significant surfaces are usually defined as those normally visible (directly or by reflection) that are essential to the appearance and serviceability of the article when assembled in normal position; or that can be the source of corrosion products that deface visible surfaces on the assembled article. Significant surfaces are further defined at those surfaces that are identified as such by the purchaser, for example, by indicating them on an engineering drawing of the product or by marking a sample item of product.

7.4.3 *Minimum Thickness Requirement*—The coating requirement of this specification is a minimum requirement; that is, the coating thickness is required to equal or exceed the specified thickness everywhere on the significant surfaces. Variation in the thickness from point to point on an article and from article to article in a production lot is inherent in mechanically deposited coatings. Therefore, if all of the articles in a production lot are to meet the thickness requirement, the average coating thickness for the production lot as a whole will be greater than the specified minimum.

NOTE 2—The thickness of mechanically deposited coatings varies from point to point on the surface of a product, characteristically tending to be thicker on flat surfaces, and thinner at exposed edges, sharp projections, shielded or recessed areas, and interior corners and holes, depending on the dimensions, with such thinner areas often being exempted from thickness requirements.

NOTE 3—Processes used to produce Type II finishes remove some of the coating. Because thickness requirements apply to the finished article, additional thicknesses may have to be applied to compensate for the metal removed in the Type II process.

7.5 *Adhesion*—The coating shall be adherent, as defined or tested in accordance with 9.6.

7.6 *Corrosion Resistance:*

7.6.1 *Type I Coatings on Ferrous Articles*—Type I coated ferrous articles shall not develop red corrosion products (“rust”) when submitted to the 5 % salt spray test for the following times:

Class 7	36 h
Class 12	72 h
Class 25	192 h
Class 50	300 h

7.6.2 *Type II Coatings, White Corrosion*—Type II coatings shall not develop white corrosion products when submitted to the salt spray test for 72 h. The organic coating or lubricant shall be removed from Type IId coatings before the test or the test can be run on articles that are withdrawn from processing before the organic coating is applied.

7.6.3 *Type II Coatings on Ferrous Articles*—Type II coated ferrous articles shall not develop red corrosion products (“rust”) when submitted to the 5 % salt spray test for the following times:

Class 7	72 h
Class 12	96 h
Class 25	192 h
Class 50	300 h

The organic coating or lubricant shall be removed from Type IId coatings before the salt spray test or the test can be run on articles that are withdrawn from processing before the organic coating is applied.

NOTE 4—In many instances, there is no direct relation between the results of an accelerated corrosion test and the resistance to corrosion in other tests or actual environments, because several factors that influence the progress of corrosion, such as the formation of protective film, vary greatly with the conditions encountered. The results obtained in the test should not, therefore, be regarded as a direct guide to the corrosion resistance of the tested materials in all environments where these materials may be used. Also, performance of different materials in the test cannot always be taken as a direct guide to the relative corrosion resistance of these materials in service.

8. Sampling

8.1 The purchaser and producer are urged to employ statistical process control in the coating process. Properly performed, statistical process control will assure coated products of satisfactory quality and will reduce the amount of acceptance inspection. The sampling plan used for the inspection of the quality coated article shall be agreed upon between the purchaser and producer.

8.1.1 When a collection of coated articles (inspection lot, see 8.2) is examined for compliance with the requirements placed on the articles, a relatively small number of the articles (sample) is selected at random and is inspected. The inspection lot is then classified as complying with the requirements based on the results of the inspection of the sample. The size of the sample and the criteria for compliance are determined by the application of statistics. The procedure is known as sampling inspection. Test Method B602, Guide B697, and Test Method B762 contain sampling plans that are designed for sampling inspection of coatings.

8.1.2 Test Method B602 contains four sampling plans, three for use with tests that are nondestructive and one when they are destructive. Test Method B602 provides a default plan if one is not specified.

8.1.3 Guide B697 provides a large number of plans and also gives guidance in the selection of a plan. Guide B697 provides a default plan if one is not specified.

8.1.4 Test Method B762 can be used only for coating requirements that have a numerical limit, such as coating thickness. The test must yield a numeric value and certain statistical requirements must be met. Test Method B762 contains several plans and also gives instructions for calculating plans to meet special needs. Test Method B762 provides a default plan if one is not specified.

8.1.5 Guide F1470 can be used for fasteners such as internally threaded, externally threaded and nonthreaded fasteners and washers. This guide provides for two plans: one designated the“ detection process” and one designated the “prevention process.” The purchaser and producer shall agree on the plan to be used.

8.2 An inspection lot shall be defined as a collection of coated articles that are of the same kind, that have been produced to the same specification, that have been coated by a single supplier at one time or approximately the same time,