



Standard Specification for Electrodeposited Coatings of Zinc Iron Alloy Deposits¹

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1. Scope

1.1 This specification covers the requirements for electrodeposited zinc iron alloy coatings on metals.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 The following precautionary caveat pertains to the test method portion only, Section 8, 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
- B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method

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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.

- B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
- B571 Practice for Qualitative Adhesion Testing of Metallic Coatings
- B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
- 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
- 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
- D3951 Practice for Commercial Packaging

3. Terminology

3.1 *Definitions*—Many terms used in this specification are defined in Terminology B374.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *significant surface, n*—that portion of a coated article's surface where the coating is required to meet all the requirements of the coating specification for that article.

3.2.1.1 *Discussion*—Significant surfaces are usually those that are essential to the serviceability or function of the article, or that can be a source of corrosion products or tarnish films that interfere with the function or desirable appearance of the article. Significant surfaces are those surfaces that are identified by the purchaser by, for example, indicating them on an engineering drawing of the product or marking a sample item of the product.

4. Classification

4.1 There is one class of zinc iron alloy that is defined as follows:

4.1.1 *Class 1*—Deposits having approximately 99 mass % zinc, balance iron.

4.2 There are two coating types that are defined as follows:

4.2.1 *Type A*—Zinc iron with black chromate conversion coating, and

4.2.2 *Type B*—Zinc iron with iridescent yellow chromate conversion coating.



4.3 There are three coating grades according to thickness that are defined as follows:

Minimum Thickness, μm	New ASTM Grade	Old ASTM Grade
6	6	1
12	12	2
18	18	3

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 in the purchase order and drawings:

5.1.1 Title, ASTM designation number, and date of issue of this specification,

5.1.2 Deposit by classification including class (see 4.1), type (see 4.2), and grade (see 4.3),

5.1.3 Composition and metallurgical condition of the substrate to be coated,

5.1.4 Location of significant surfaces (see 3.2),

5.1.5 Heat treatment for stress relief, whether it has been performed by purchaser or is required (see 6.7),

5.1.6 Heat treatment after electroplating, if required (see 6.8),

5.1.7 Any requirement for submission of sample coated articles,

5.1.8 Whether or not location of rack marks is to be defined (see 6.3.1),

5.1.9 Any requirement for special test specimens (see 8.1),

5.1.10 Acceptance inspection procedure to be used (see Section 8),

5.1.11 Any requirement for certification (see Section 10), and

5.1.12 Any other items needing agreement. For the purposes of this specification, prior agreement on the nature of the finish is required as items plated in bulk may differ slightly in appearance from those that are rack plated.

6. Coating Requirements

6.1 *Substrate*—The metal to be plated shall be free of flaws and defects that will be detrimental to the zinc alloy coating. It shall be subjected to such cleaning, pickling, and electroplating procedures as are necessary to yield deposits with the desired quality.

NOTE 1—Proper preparatory procedures and thorough cleaning are essential to ensure satisfactory adhesion and corrosion resistance performance of the coating. Materials used for cleaning should not damage the basis metal. It is recommended that the following practices for cleaning be used, where appropriate: Practices B183 and B320, and Guides B242 and B322.

6.1.1 The electroplating shall be applied after all basis metal heat treatments have been completed.

6.2 *Nature of Coating*—The coating shall consist of a zinc iron alloy that is approximately 99 mass % zinc and the balance iron.

6.3 *Appearance:*

6.3.1 The coating on all readily visible surfaces shall have an acceptable and characteristic appearance as agreed upon by the purchaser and seller. The coating shall be uniform insofar as the basis metal will permit. When the article is to be plated

on a rack, contact marks may be unavoidable. Location of such marks(s) shall be indicated on the article or its drawing.

6.3.2 Defects and variations in appearance that arise from surface conditions of the substrate (scratches, pores, roll marks, inclusions, and the like) and that persist in the coating despite the observance of good metal finishing practices shall not be cause for rejection. The coating shall be adherent, free from blisters, pits, or discontinuities, and shall be free of cracks in the as-plated state. Flaking shall be cause for rejection in either the as-plated state or after subsequent operations.

NOTE 2—These coatings are commonly used in automotive applications where subsequent forming, bending, and crimping operations are commonly performed. These operations will necessarily detract from the performance of the coatings. While some cracking of coatings will be unavoidable, flaking of the coating after these subsequent operations shall be cause for rejection.

NOTE 3—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 product 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 application of the coating. When they are desired, they are the subject of special agreement between the purchaser and the seller.

6.4 *Thickness*—The thickness of the coating everywhere on the significant surfaces shall conform to the requirements as specified in 4.2 and defined in 3.2.1.

NOTE 4—The coating requirement of this specification is a minimum. Variation in the thickness from point to point on an article and from article to article in a production lot is inherent in electroplating. 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.

6.5 *Adhesion*—The coating shall withstand normal handling and storage conditions without chipping, flaking, or other coating damage and shall conform to the minimum requirements set forth in Section 8.

6.6 *Corrosion Resistance*—The corrosion resistance of the coating may be evaluated using the method in Appendix X1.

6.7 *Pretreatment of Iron and Steel to Reduce the Risk of Hydrogen Embrittlement:*

6.7.1 Parts that are made of steels with ultimate tensile strengths of 1000 MPa (hardness of 31 HRC or greater) that have been machined, ground, cold formed, or cold straightened subsequent to heat treatment shall require stress relief heat treatment when specified by the purchaser, the tensile strength to be supplied by the purchaser. Specification B849 may be consulted for a list of pretreatments that are widely used.

6.8 *Coating Treatments of Iron and Steel to Reduce the Risk of Hydrogen Embrittlement:*

6.8.1 Parts that are made of steels with ultimate tensile strengths of 1000 MPa (hardness of 31 HRC or greater) as well as surface hardened parts, may require post-coating hydrogen embrittlement relief baking when specified by the purchaser, the tensile strength to be supplied by the purchaser. Guide B850 may be consulted for a list of post-treatments that are widely used.



7. Sampling

7.1 The sampling plan used for the inspection of a quantity of the coated articles shall be as agreed upon between the purchaser and the seller.

NOTE 5—Usually, when a collection of coated articles, the inspection lot (see 7.2), is examined for compliance with the requirements placed on the articles, a relatively small number of the articles, the sample, is selected at random and is inspected. The inspection lot is then classified as complying or not 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. This procedure is known as sampling inspection. Three standards, Test Method B602, Guide B697, and Test Method B762, contain sampling plans that are designed for the sampling inspection of coatings. Test Method B602 contains four sampling plans, three for use with tests that are nondestructive and one for destructive tests. The buyer and seller may agree on the plan or plans to be used. If they do not, Test Method B602 identifies the plan to be used. Guide B697 provides a large number of plans and also gives guidance in the selection of a plan. When Guide B697 is specified, the buyer and seller need to agree on the plan to be used. Test Method B762 can be used only for coating requirements that have a numerical limit, such as a coating thickness. The test must yield a numerical 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. The buyer and the seller may agree on the plan or plans to be used. If they do not, Test Method B762 identifies the plan to be used.

NOTE 6—When both destructive and nondestructive tests exist for the measurement of a characteristic, the purchaser needs to state which is to be used so that the proper sampling plan is selected. A test may destroy the coating but in a noncritical area, or, although it may destroy the coating, a tested part can be reclaimed by stripping and recoating. The purchaser needs to state whether the test is to be considered destructive or nondestructive.

7.2 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 at approximately the same time under essentially identical conditions, and that are submitted for acceptance or rejection as a group.

7.3 If special test specimens are used to represent the coated articles in a test, the number used shall be that required in 8.1.1.

8. Test Methods

8.1 Special Test Specimens:

8.1.1 The permission or the requirement to use special test specimens, the number to be used, the material from which they are to be made, and the shape and size of the specimens, shall be stated by the purchaser.

NOTE 7—Test specimens often are used to represent the coated articles in a test if the articles are of a size, shape, or material that is not suitable for the test, or if it is preferred not to submit articles to a destructive test because, for example, the articles are expensive or few in number. The specimen should duplicate the characteristics of the article that influence the property being tested.

8.1.2 Special test specimens used to represent articles in an adhesion, porosity, corrosion resistance, or appearance test shall be made of the same material, in the same metallurgical condition, and have the same surface condition as the articles they represent, and be placed in the production lot of and be processed along with the articles they represent.

8.1.3 Special test specimens used to represent articles in a coating thickness test may be made of a material that is suitable for the test method even if the represented article is not of the same material. For example, a low-carbon steel specimen may represent a brass article when the magnetic thickness test is used (see Test Method B499). The thickness specimen need not be carried through the complete process with the represented article. If not, introduce it into the process at the point where the coating is applied and carry it through all steps that have a bearing on the coating thickness. In rack plating, rack the specimen in the same way with the same distance from and orientation with the anodes and other items in the process as the article it represents.

NOTE 8—When special test specimens are used to represent coated articles in a thickness test, the specimens will not necessarily have the same thickness and thickness distribution as the articles unless the specimens and the articles are of the same general size and shape. Therefore, before finished articles can be accepted on the basis of a thickness test performed on special test specimens, the relationship between the thickness on the specimen and the thickness on the part needs to be established. The criterion of acceptance is that thickness on the specimen that corresponds to the required thickness on the article.

8.2 *Composition of Coating*—Verify the composition of the coating by atomic absorption spectrophotometry (AA), inductively coupled plasma (ICP), or directly coupled plasma (DCP) or other methods if found to be capable of results within 10 % of known standards.

8.3 *Appearance*—Examine the coating at up to 10 × magnification for conformance to the requirements of appearance.

8.4 *Thickness*—Measure the coating thickness at locations on the significant surface designated by the purchaser, and make the measurement with an accuracy of 10 % or better by use of one of the following test methods: Test Methods B487, B499, B504, or B568.

8.5 *Adhesion*—Test the adhesion of the coating in accordance with Practice B571. The choice of test method shall be one of those appropriate for zinc coatings.

8.6 *Corrosion Resistance*—See Appendix X1.

9. Rejection and Rehearing

9.1 Articles that fail to conform to the requirements of this specification may be rejected. Rejection shall be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of a test, the producer or supplier may make a claim for a rehearing. Coatings that show imperfections during subsequent manufacturing operations may be rejected.

10. Certification

10.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

**11. Packaging**

11.1 The packaging and packing requirements shall be in accordance with Practice **D3951** or as specified in the contract or order.

12. Keywords

12.1 alloy zinc; coatings—corrosion resistant; electrodeposited zinc iron; zinc alloy; zinc iron

APPENDIX**(Nonmandatory Information)****X1. CORROSION RESISTANCE**

X1.1 The corrosion resistance of the coating may be evaluated using Practice **B117**. **Table X1.1** suggests durations of

continuous testing that properly applied coatings should withstand, but are to be used as a guide only.

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TABLE X1.1 Durations of Continuous Testing for Corrosion Resistance

Class	Type	Grade	Typical Appearance	Base Metal Corrosion	Zinc Corrosion Product
1	A	1	black	700	270
1	A	2	black	740	300
1	A	3	black	800	300
1	B	1	yellow	470	180
1	B	2	yellow	540	210
1	B	3	yellow	700	210

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