



Standard Specification for Hard-Coat Anodizing of Magnesium for Engineering Applications¹

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1. Scope

1.1 This specification covers requirements for electrolytically formed oxide coatings on magnesium and magnesium alloy parts where appearance, abrasion resistance, and protection against corrosion are important.

1.2 *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](#)
- [B244 Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments](#)
- [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](#)
- [B537 Practice for Rating of Electroplated Panels Subjected to Atmospheric Exposure](#)
- [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](#)
- [D3951 Practice for Commercial Packaging](#)

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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.

D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

3. Terminology

3.1 Definitions:

3.1.1 *Definitions*—For definitions of terms relating to this specification see Terminology B374.

3.1.2 *anodizing*—an electrolytic oxidation process in which the surface of a metal, when anodic, is converted to a coating having desirable protective or functional properties.

3.1.3 *hard coat*—in anodizing magnesium, an anodic oxide coating on magnesium with a higher apparent density and thickness, and a greater resistance to wear than the base metal.

4. Classification

4.1 Coating Designation—Thickness.

4.1.1 Minimum thickness of 20 μm .

4.2 TYPE—Post treatments.

4.2.1 TYPE A—No post treatment.

4.2.2 TYPE B—Purchaser specified.

5. Ordering Information (to be supplied by the purchaser to the producer.)

5.1 *Alloy Designation*—When ordering articles anodized in accordance with this specification, the purchaser shall state, the alloy designation number.

5.2 *Appearance*—Unless otherwise specified by the purchaser, an off-white color shall be acceptable for TYPE A coating. The purchaser shall specify the color and surface appearance required for TYPE B coatings. All coatings shall be uniform in color and free from stains. Alternatively, samples showing the required finish, or range of finishes, shall be supplied or approved by the purchaser. When required, the basis material may be subjected to such mechanical polishing as may be required to yield the desired final surface characteristics.

5.3 *Significant Surface*—The areas of the article covered by the coating, for which the coating is essential for service or appearance or both.

5.3.1 *Contact Marks*—Contact marks will occur. The purchaser shall specify where contact marks are unacceptable.

5.4 *Tolerances*—Dimensional build-up is approximately one-half of anodic film thickness. The order document shall include any coating thickness tolerances and shall not exceed any applicable drawing dimensions.

5.5 The purchaser shall provide the number for this standard TYPE.

5.6 The purchaser shall state any special post treatments (see 4.2 and 5.2).

5.7 *Test Methods*—The purchaser shall state the test method(s) by which the coated article will be evaluated (see Section 8).

5.8 *Sampling Plan*—see Section 9.

5.9 Any requirement for certification (see Section 11).

5.10 Any requirement for packaging (see Section 12).

6. Materials and Process

6.1 *Process:*

6.1.1 *Basis Metal*—This specification does not specify requirements for the surface condition of the basis metal before anodizing, but agreement should preferably be reached between the purchaser and the producer that the surface condition of the basis metal is satisfactory.

6.1.2 *Surface Preparation*—Preparatory procedures and cleaning of the basis material may be necessary, see Practice B322.

6.1.3 *Hard-Coating*—Following the preparatory operations, the articles are introduced into the solution for a period of time at the current density and temperature required to produce the hard-coated surface.

NOTE 1—Hard-coating solutions and operating conditions are commercially available. The appropriate operating instructions should be followed.

NOTE 2—Intricately shaped articles may not receive the same thickness of coating in recessed areas due to lower current densities. Auxiliary cathodes, may be used to improve anodize thickness in these areas.

6.2 *Post Treatments:*

6.2.1 *Final Rinsing*—Rinsing subsequent to anodizing is necessary to remove all traces of the electrolyte that may affect the appearance and performance of the part. Deionized or distilled water may be used to avoid water spots.

6.2.2 *Post Treatment*—Surface sealers or topcoats may be specified to reduce friction, add color, or further increase performance.

7. Requirements

7.1 *Acceptance:*

7.1.1 *Visual Defects*—The significant surfaces of the article to be hardcoated shall be free of clearly visible defects such as pits, roughness, striations, or discoloration when examined with normal or corrected to 20/20 eyesight at a distance of approximately 0.5 m.

NOTE 3—Defects in the surface of the basis material such as scratches, porosity, inclusions, etc., may adversely affect the appearance and performance of the article.

7.1.2 *Thickness:*

7.1.2.1 *Coating Thickness for SC20*—The anodic film thickness shall be a minimum of 20 μm and not exceed 30 μm on the significant surface.

7.1.2.2 *Test*—Hard-coating thickness shall be evaluated by one or more of the following test methods in Section 8.

7.2 *Qualification Tests*—The process shall be evaluated monthly or more frequently if required by the purchaser using the following test methods on panels that are of the same alloy of the parts coated with TYPE A hard coat.

7.2.1 *Corrosion Test*—Use method described in 8.1.

7.2.2 *Abrasion Resistance Test*—Use the Taber Abraser test method in Annex A1 of this specification.

8. Test Methods

8.1 *Corrosion Test*—Panel(s) shall be subjected to a 5 % salt spray (fog) test in accordance with Practice B117 for 336 h. The panel(s) shall be prepared and evaluated in accordance with Practice B537. A protective rating of 6 or less is considered a failure.

8.2 *Abrasion Resistance Test*—Test panels in accordance with Annex A1. The acceptance criteria shall be as follows.

8.2.1 *Abrasive Wheel No. CS-10*—A wear index of more than 7 mg/1000 cycles or less than 10 000 wear cycles shall be considered a failure.

8.2.2 *Abrasive Wheel No. CS-17*—A wear index of more than 20 mg/1000 cycles or less than 5 000 wear cycles shall be considered a failure.

8.3 *Thickness Tests:*

8.3.1 *Eddy-Current Method* (Test Method B244).

8.3.2 *Microscopical Cross Section Method* (Test Method B487).

9. Sampling

9.1 The purchaser and producer are urged to employ statistical process control in the coating process. Properly performed, statistical process control will ensure 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.

9.1.1 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.

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

9.1.3 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.

9.1.4 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.

9.2 An inspection lot shall be defined as a collection of coated articles that are 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, under essentially identical conditions, and that are submitted for acceptance or rejection as a group.

10. Rejection and Hearing

10.1 Parts that fail to conform to the requirements of this specification may be rejected. Rejection should be reported to

the producer or supplier promptly, and in writing. In case of dissatisfaction with test results, the producer or supplier may make a claim for a rehearing.

11. Certification

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

12. Packaging

12.1 If packaging requirements are necessary under this specification, they shall be in accordance with Practice **D3951**.

13. Keywords

13.1 anodizing; hard coat; magnesium

ANNEX

(Mandatory Information)

A1. TABER ABRASER WEAR TEST METHOD

A1.1 Scope

A1.1.1 This test method will evaluate the resistance of the coating to abrasive wear. The test is performed by coating a special specimen with the coating of interest, mechanically rotating the panel under an abrasive wheel and measuring the loss of material. The test is generally performed to 5000 cycles with CS-17 or 10 000 cycles with a CS-10 but can be extended to as high as 25 000 cycles.

NOTE A1.1—Variations in the results of this test method have been attributed to humidity in the laboratory and storage conditions of the wheels. Care should be taken to control the humidity of the wheels between tests.

A1.1.2 The results are variable between tests and therefore three (3) coated test specimens should be tested for 5000 or 10 000 cycles each depending on the type of abrasive wheel. The results should be averaged and the abrasion wear reported as the weight loss in mg/1000 cycles (Taber Wear Index).

NOTE A1.2—The outer surface of the coating may contain roughness or in the case of anodizing may be less dense which will cause a greater loss in the first 1000 cycles than the remaining cycles. By not reporting the first 1000 cycles a more representative value for the bulk coating is obtained. For these applications, however the outer density and wear debris in the first 1000 cycles is important.

A1.2 Apparatus

A1.2.1 *Taber Abraser Wear Testing Unit*—This unit must be capable of applying a 1000 g load on the wheel and have an operating vacuum for removal of wear debris while in test.

A1.2.2 *Abrasion Wheels*—Use the CS10 or CS17 (Resilient Rubber) Taber Wheels. To resurface the wheels use the CS11 discs from Taber.

NOTE A1.3—The hardness of the wheels can change with time and can effect the reproducibility of the results. (see Test Method **D4060**) Redressing the wheels as well as using new wheels and controlling the humidity will improve the reproducibility. Round Robin tests between laboratories has produced a bias of 50 % with these factors in control while the intra laboratory bias is 20 %.

A1.2.3 *Specimens*—Test specimens shall be made from magnesium plate 4 by 4 by 0.250 in. min (100 by 100 by 2 mm to 6.35 mm) with a 0.250 in. (6.35 mm) hole in the center.

A1.2.4 *Analytical Balance*—Scale shall be capable of measuring to 150 g \pm 0.1 mg.

A1.3 Procedure

A1.3.1 *Coat Specimens*—Coat a set of three (3) specimens to the thickness of 20 to 30 μ m.

A1.3.2 *Testing Specimens*—Perform the following test on each of the three specimens.

A1.3.2.1 *Step 1—Weigh Specimens*—Cool the specimen to ambient temperature and weigh to the nearest 0.1 mg.

A1.3.2.2 *Step 2—Dress Wheel*—The wheel shall be dressed using a CS11 disc for 50 cycles.

A1.3.2.3 *Step 3, Wear Specimens*, 5000 cycles for CS-17 or 10 000 cycles for a CS-10. Test the specimens by loading the wheel to 1000 g and wearing the specimen for the required cycles.

A1.3.2.4 *Step 4, Weigh Specimen*—Cool the specimen to ambient temperature and weigh to the nearest 0.1 mg.

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