



Designation: A 428/A 428M – 95

Standard Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles¹

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1. Scope

1.1 This test method covers procedures for determining the weight [mass] of coating on aluminum-coated iron or steel sheets and wire, and on other aluminum-coated iron and steel articles.

1.2 The final results determined by this test method shall be expressed in inch-pound units or SI units, depending on the units used in the material specification to which the results are to be compared. Certain portions of the procedure involving determination of specimen weight [mass] have traditionally been performed in SI units, and corresponding inch-pound units are not included.

1.3 In this test method, the quantity of material is described in terms of weight [mass]. Weight is the force describing the gravitation attraction of the earth on a quantity of material. In general usage on the surface of the earth, mass of an unknown quantity is determined by comparing with a known quantity (either directly or indirectly and ignoring the buoyancy of the air) as indicated by the attraction of the earth's gravity, thus weight is actually determined. See Appendix X1 of Terminology E 12 for further discussion of weight and mass.

1.4 *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.* For a specific precautionary statement, see Note 1.

2. Referenced Documents

2.1 ASTM Standards:

D 1193 Specification for Reagent Water²

E 12 Terminology Relating to Density and Specific Gravity of Solids, Liquids, and Gases³

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance With Specifications⁴

E 691 Practice for Conducting an Interlaboratory Study to

Determine the Precision of Test Methods⁵

3. Significance and Use

3.1 This test method provides a standard method of determining the weight [mass] of coating for comparison with specification requirements. A coating of aluminum on iron or steel articles provides protection against corrosion by forming a relatively inert barrier. Specifications for aluminum-coated articles occasionally provide for different classes (weights) [masses] of coating so that the purchaser can select the coating weight [mass] most suited to his needs. The heavier coating will provide greater protection against mechanical damage which may break the coating.

4. Reagents

4.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁶ Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

4.2 *Purity of Water*—Water used in preparation of reagent solutions shall conform to Specification D 1193, Type IV or better.

4.3 *Antimony Trichloride Solution*—Dissolve 200 g of antimony trichloride (SbCl₃) in 1000 mL of concentrated hydrochloric acid (HCl, sp gr 1.19) without heating.

4.4 *Hydrochloric Acid* (sp gr 1.19)—Concentrated hydrochloric acid (HCl).

4.5 *Sodium Hydroxide Solution* (20 %)—Dissolve 20 parts by weight [mass] of sodium hydroxide (NaOH) in 80 parts of water.

4.6 *Stannous Chloride Solution*—Dissolve 100 g of stannous chloride (SnCl₂·2H₂O) in 1000 mL of concentrated hydrochloric acid (HCl, sp gr 1.19) without heating. Add a few

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² *Annual Book of ASTM Standards*, Vol 11.01.

³ *Annual Book of ASTM Standards*, Vol 15.05.

⁴ *Annual Book of ASTM Standards*, Vols 02.03 and 14.02.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

⁶ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

granules of reagent grade tin.

NOTE 1—Warning: Small amounts of the poisonous gas stibine (SbH_3) may be evolved during the stripping process using the hydrochloric acid-antimony trichloride-stannous chloride method. Hydrochloric acid fumes are present, and hydrogen gas is evolved in the stripping process. Therefore, the test should be performed under conditions of adequate ventilation. A fume hood is recommended for large numbers of samples or where the test is to be carried out frequently over extended periods of time.

5. Sampling

5.1 Aluminum-Coated Sheets—Samples for weight-of-coating [mass-of-coating] determination shall be secured as designated in the appropriate specification. Test specimens shall have a minimum area of 3 in.² [2000 mm²] of sheet, but preferably approximately 5 in.² [3300 mm²] of sheet.

NOTE 2—For convenience in calculating test results in inch-pound units, the specimen should have an area of 5.08 in.² of sheet (2.25 ± 0.01 in. square or 2.54 ± 0.01 in. in diameter). The weight [mass] of coating in grams on a specimen of that area is numerically equal to the weight [mass] of coating in ounces per square foot of sheet. For results to be reported in SI units, the specimen should have an area of 3330 mm² of sheet (57.7 ± 0.1 mm square or 65.1 ± 0.1 mm in diameter).

5.2 Aluminum-Coated Wire—Samples shall be secured as designated in the appropriate specification. The specimen of aluminum-coated wire may be of any length over 12 in. (approximately 300 mm), but preferably about 24 in. (approximately 600 mm). Where a continuous length is not available, shorter lengths totaling over 12 in., but preferably about 24 in., shall be used. Since the density of the steel is known (0.283 lb/in.³ or 7830 kg/m³), it is not necessary to use a specific length of specimen.

5.3 Aluminum-Coated Articles Other Than Sheet or Wire—Samples for weight [mass] of coating determination shall be secured as designated in the appropriate specification. Except as otherwise provided, the specimens should have a minimum area of 3 in.² [1935 mm²] of aluminum-coated surface. For very small items, several pieces may have to be stripped to obtain the minimum area.

5.3.1 In the case of threaded articles, such as bolts and screws, the determination shall be made on a portion of the article that does not include any thread.

6. Procedure

6.1 Stripping of the aluminum coating from the specimens may be done using the sodium hydroxide-hydrochloric acid method or the hydrochloric acid-antimony trichloride-stannous chloride method.

6.2 Clean the specimens immediately before determining the weight [mass] by washing in petroleum ether or other suitable solvent, and dry thoroughly.

6.3 Determine the weight [mass] of the specimens individually to the nearest 0.01 g.

6.4 Sodium Hydroxide-Hydrochloric Acid Method—Heat the NaOH solution to approximately 90°C (Note 3) and immerse each specimen in the hot solution until the strong reaction ceases. With silicon-free coatings, gas may be evolved for considerable time, but the specimens should not be left in the solution for more than a few minutes. Longer immersion inhibits the removal of coating during subsequent dips. Several

specimens may be immersed simultaneously provided all surfaces are freely exposed to the solution. Remove specimens from solution and scrub all surfaces under running tap water with a clean cellulose sponge to remove the loose deposit formed in the NaOH solution. Rather vigorous scrubbing may be necessary for some types of coating, but abrasive materials should not be used to remove the deposit. Blot with a towel to remove most of the water (Note 4) and immerse each specimen singly for not more than 3 s in HCl at room temperature. Remove, scrub again under running tap water with a sponge, and reimmerse in the hot NaOH solution for not more than a few minutes or until action again ceases. Repeat this cycle until immersion in HCl shows no visible reaction (Note 5). One to three or more cycles may be required, depending on the type and weight of coating. After the final immersion in the NaOH and HCl solutions, scrub as before, dry thoroughly, and determine the weight [mass] of each specimen to the nearest 0.01 g.

NOTE 3—This temperature is not critical, but the solution should be held several degrees below the boiling point (approximately 105°C) to prevent excessive foaming during the first immersion. The beaker used for heating the solution and immersing the specimens should be less than half full of solution to avoid the danger of foaming over when the specimens are immersed.

NOTE 4—Most of the water should be removed to prevent dilution of the HCl, as dilute HCl will attack the base metal to a greater extent than concentrated HCl.

NOTE 5—It is sometimes difficult to determine the point at which all of the alloy layer has been removed, when stripping silicon-free coatings. If in doubt, determine the weight [mass] of the specimen (after scrubbing and drying) and then put it through one additional stripping cycle. Loss in weight [mass] due to the additional cycle will be of the order of 0.005 g on a 2.25-in. [57.2-mm] square sheet specimen, if all the coating had been removed before the extra cycle.

6.5 Hydrochloric Acid-Antimony Trichloride-Stannous Chloride Method—After determining the weight [mass], immerse each specimen singly in a solution made by mixing 100 mL of antimony trichloride solution and 100 mL of stannous chloride solution (Note 6). Allow the specimen to remain immersed until the evolution of hydrogen has ceased. Action will stop after 1 to 4 min, or somewhat longer, depending on the thickness and silicon content of the coating. A fresh solution must be used for each test (Note 7). The temperature of the stripping solution should not exceed 38°C. After stripping, wash the specimen and scrub it with a soft cloth, using a small amount of abrasive cleansing powder if necessary. Rinse, and dry with an absorbent cloth or paper. Again determine the weight [mass] of the specimens to the nearest 0.01 g.

NOTE 6—Mix the antimony trichloride and stannous chloride solutions together as needed.

NOTE 7—Very heavy coatings may show residual coating after all action has stopped. If on examination after stripping, any coating still remains, repeat the immersion step using fresh solution.

6.6 Sheet Specimens—Determine the area of sheet (one surface) to the nearest 0.01 in.² [5 mm²]. If specimens were prepared to the dimensions as provided in Note 2, they shall be presumed to have an area of 5.08 in.² [3330 mm²]. When it is not possible to determine the area accurately, as in specimens from corrugated sheets, determine the average thickness of the