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Standard Guide for
Determining Mass Per Unit Area of Electrodeposited and Related Coatings by Gravimetric and Other Chemical Analysis Procedures[1]

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1. Scope

1.1 This guide outlines a general method for determining the mass per unit area of electrodeposited, electroless, mechanically-deposited, vacuum-deposited, anodicoxide, and chemical conversion coatings by gravimetric and other chemical analysis procedures.

1.2 This guide determines the average mass per unit area over a measured area.

1.3 The stripping methods cited are described in specifications or in the open literature or have been used routinely by at least one laboratory.

1.4 The procedures outlined can be used for many coating-substrate combinations. They cannot be used where the coating cannot be separated from the substrate by chemical or physical means as would be the case if white brass were plated with yellow brass.

1.5 In principle, these procedures can be used to measure very thin coatings or to measure coatings over small areas, but not thin coatings over small areas. The limits depend on the required accuracy. For example, 2.5 mg/cm^2 of coating might require 2.5 mg of coating covering 1 cm^2, but 0.1 mg/cm^2 of coating would require 25 cm^2 to obtain 2.5 mg of coating.

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

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
A309 Test Method for Weight and Composition of Coating on Terne Sheet by the Triple-Spot Test (Withdrawn 2015)[3]
A428/A428M Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles
B137 Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum
B449 Specification for Chromates on Aluminum

2.2 *British Standards Institution Documents:*[4]

BS 729 Hot Dip Galvanized Coatings on Iron and Steel Articles, Specification for
BS 1706 Electroplated Coatings of Cadmium and Zinc on Iron and Steel, Specification for
BS 1872 Electroplated Coatings of Tin, Specification for
BS 3189 Phosphate Treatment of Iron and Steel, Specification for
BS 3382 Electroplated Coatings on Threaded Components, Specification for
BS 3597 Electroplated Coatings of 65/35 Tin-Nickel Alloy, Specification for

2.3 *Government Standards:*

2.3.1 *DOD Standard:*[5]

DOD-P-16232F Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals)

2.3.2 *Federal Standards:*[6]

FED-STD 151b Metals; Test Methods: Test 513.1 for Weight of Coating on Hot Dip Tin Plate and Electrolytic Tin Plate

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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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

[6] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.

RR-T-51D Tableware and Flatware—Silverplated

2.3.3 *Military Standard:*[5]

MIL-M-45202C Magnesium Alloys, Anodic Treatment of

2.4 *ISO Standards:*[7]

ISO 2081 Metallic Coatings—Electroplated Coatings of Zinc on Iron or Steel

ISO 2082 Metallic Coatings—Electroplated Coatings on Cadmium on Iron or Steel

ISO 2093 Metallic Coatings—Electrodeposited Coatings of Tin, Annex B

ISO 2106 Anodizing of Aluminum and its Alloys—Determination of Mass Per Unit Area (Surface Density) of Anodic Oxide Coatings—Gravimetric Method

ISO 3892 Conversion Coatings on Metallic Materials—Determination of Coating Mass Per Unit Area—Gravimetric Methods

ISO 4522/1 Metallic Coatings—Test Methods for Electrodeposited Silver and Silver Alloy Coatings—Part 1: Determination of Coating Thickness

ISO 4524/1 Metallic Coatings—Test Methods for Electrodeposited Gold and Gold Alloy Coatings—Part 1: Determination of Coating Thickness

3. Summary of Guide

3.1 The mass of a coating over a measured area is determined by the following:

3.1.1 Weighing the test specimen before and after dissolving the coating in a reagent that does not attack the substrate.

3.1.2 Weighing the coating after dissolving the substrate in a reagent that does not attack the coating, or

3.1.3 Dissolving both the coating and the substrate and quantitatively analyzing the resulting solution.

3.2 The mass per unit area is calculated from the mass and area measurements, the thickness from the mass, area, and density of the coating materials.

4. Significance and Use

4.1 The thickness of a coating is critical to its performance and is specified in many specifications calling for coatings.

4.2 These procedures are used for acceptance testing and appear in a few specifications.

4.3 Coating thickness instruments are often calibrated with thickness standards that are based on mass and area measurements.

4.4 The average thickness of a coating on the measured area can be calculated from its mass per unit area only if the density of the coating material is known.

5. Apparatus

5.1 In addition to normal chemical laboratory equipment for handling small amounts of corrosive and toxic chemicals, an accurate ruler or vernier caliper and a good balance are required. See Sections 7 and 8.

6. Specimen Preparation

6.1 *Size*—The specimen must be large enough to permit area and mass measurement of adequate accuracy. (See Section 7 and 8.2.)

6.2 *Shape*—The shape of the test specimen must be such that the surface area can be easily measured. A rectangular or circular test specimen is usually suitable.

6.3 *Edge Condition*—If the area to be measured is small and needs to be known accurately, the edges must be dressed to remove smeared coating, to remove loose burrs, and to provide well-defined and (for rectangles) straight edges. This should be considered for areas less than 100 mm^2. One method of dressing the edges of a rectangular specimen is to clamp the specimen between two plastic or metal blocks with the edge of the specimen flush with the edges of the blocks and then to grind and polish the edges metallographically.

6.4 *Heat Treatment*—If the substrate is to be dissolved leaving the coating intact, it is desirable to first heat-treat the test specimen so that the coating will not curl up tightly or fall apart. Some gold deposits of 1.5 mg/cm^2 will fall apart when their substrates are dissolved, but after heat treatment at 120°C for 3 h will support themselves. If the thickness of a coating (instead of its mass per unit area) is being determined, one should not use a heat treatment that might change the density of the coating material.

7. Measurement of Coated Area:

7.1 *Measurement Method*—The accuracy of the area measurement must be better than the desired accuracy of the mass per unit area measurement. Hence the method of measuring the area will depend on the desired accuracy and the specimen size.

7.2 *Equipment*—The area can be measured with a planimeter, but it is usually determined by linear measurements. Often a micrometer or vernier caliper is used. For large areas, however, a ruler may do. For maximum accuracy, a measuring microscope is used.

7.3 *Number of Measurements*—Because circular or rectangular specimens will not be perfectly circular or rectangular, it is desirable to measure each dimension in three places. For a rectangle, one would measure the length of each edge and the length and width through the center and obtain an average for each dimension.

NOTE 1—In the case of a cylinder one would normally measure the diameter and length. In one specification for galvanized wire (fencing), the length of the wire specimen is not measured, but in effect is calculated from the mass (which is measured anyway), the radius, and the density of the steel substrate. ($l = m/\pi r^2 D$)

8. Gravimetric Determination of Mass of Coating:

8.1 *Specimen Size*—The accuracy of the mass measurement must be better than the desired accuracy of the mass per unit area measurement. Hence, the test specimen must be large enough that the coating can be weighed with the desired accuracy.

8.2 *Equipment*—A balance is required, but the required sensitivity of the balance depends on the size of the test

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[7] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

specimen, the coating thickness (coating mass), and the required accuracy of the measurement. A balance that weighs to 0.01 g is sometimes satisfactory, though a good analytical balance weighing to 0.0001 g is more versatile. A microbalance is required for small specimens of thin coatings, but it is limited to small samples.

9. Procedure

9.1 The mass of coating may be determined: (*1*) by weighing the test specimen before and after dissolving the coating (see Annex A1) and taking the difference, or (*2*) by dissolving the substrate (see Annex A1) and weighing the coating directly.

9.1.1 *By Difference*—The test specimen is first cleaned of any foreign material and finally rinsed with alcohol, blown dry with clean air, and weighed. The specimen is immersed in the appropriate reagent (see Annex A1) to dissolve the coating, rinsed with water, rinsed with alcohol, blown dry with clean air, and weighed again. The loss of mass is the mass of the coating. To determine if there was any dissolution of the substrate, repeat the process with the stripped substrate making sure that it is in the reagent just as long as before. Any loss of mass enables one to make a judgment of a possible error due to any dissolution of the substrate with the coating during the stripping process.

9.1.2 *By Direct Weighing*—The substrate is dissolved in the appropriate reagent (see Annex A1). The coating is rinsed with water, rinsed with alcohol, blown dry with clean air, and weighed. To determine if there was any dissolution of the coating, submit the isolated coating to the same stripping process making sure that the coating is in the stripping reagent for the same length of time as it was during the stripping process. Any loss of mass enables one to make a judgment of a possible error due to any dissolution of the coating with the substrate during the stripping process.

NOTE 2—The test procedure given at the end of 9.1.1 and 9.1.2 should be conducted to evaluate a gravimetric method the first time it is used.

9.2 *Determination of Mass of Coating by Chemical Analysis*—This method is by nature very general. Both the coating and substrate are dissolved in a suitable reagent and then the resulting solution is analyzed for the coating material. For each coating-substrate-reagent combination, there are several analytical methods. For possible analytical methods see Volumes 03.05 and 03.06 of the *Annual Book of ASTM Standards*.

10. Calculation

10.1 Calculate the mass per unit area as follows:

$$\text{Mass per unit area} = m/A \ (\text{mg/cm}^2) \tag{1}$$

where:

m = mass of coating (mg), and
A = area covered by coating (cm^2)

10.2 Calculate the thickness as follows:

$$\text{Thickness} = 10 \times M/D \ (\mu\text{m}) \tag{2}$$

where:

M = mass per unit area (mg/cm^2), and
D = density (g/cm^3).

NOTE 3—The density of a coating metal is usually not the same as the handbook value or the theoretical value. For example, the density of electrodeposited gold is generally less than 19.3 g/cm^3 and sometimes as low or lower than 17 g/cm^3. The densities of some electrodeposited metals are given by W. H. Safranek.[8]

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[8] Printed in *The Properties of Electrodeposited Metals and Alloys*, Second Edition, American Electroplaters' and Surface Finishers Society, 1986.

ANNEX

(Mandatory Information)

A1. REAGENTS FOR SELECTIVE DISSOLUTION OF METAL LAYERS

NOTE A1.1—The specific issues of standards are cited in this table and included in the literature as references because they contain the information from which this table is based.

A1.1

With many of the reagents given in Table A1.1, there may be some dissolution of the layer other than the one being stripped. Often the dissolution is not significant, but the possibility should be tested for as suggested in 9.1.1, and 9.1.2.

A1.2

Dissolution is carried out at room temperature unless otherwise indicated. All test pieces are rinsed and dried (see 9.1.1 and 9.1.2) before weighing.

TABLE A1.1 Reagents

Coating	Substrate	Reagents	Remarks—Sources
aluminum	steel	(*1*) 20 parts by mass NaOH, 80 parts water (2) concentrated HCl (sp gr 1.19)	Immerse a few min (avoid longer time) at about 90°C. While rinsing, scrub with a sponge to remove loose material. Drain off water, immerse 3 s in concentrated HCl at room temperature, scrub again in running water, and repeat entire process until there is no visible reaction in the HCl. Two or three cycles are required normally. A more detailed description is given in the 1981 issue of Test Method A428/A428M.
aluminum	steel	(*1*) 200 g SbCl_3 in 1L concentrated HCl	Mix equal volume of *(1)* and *(2),* immerse until evolution of hydrogen stops, about 1–4 min.

TABLE A1.1 *Continued*

Coating	Substrate	Reagents	Remarks—Sources
		(*2*) 100 g $SnCl_{2.2}H_2O$ in 1L concentrated HCl plus a few granules of tin	Keep below 38°C, rinse and scrub with soft cloth. This test procedure appears in Ref **(1)** and in the 1981 issue of Test Method A428/A428M.[A]
anodized aluminum	aluminum	35 mL 85 % phosphoric acid plus 20 g/L CrO_3	Immerse 5 min at 100°C, rinse, dry, weigh. Repeat cycle until weight is constant. This procedure appears in the 1945 issue of Test Method B137 and the 1982 issue of ISO Standard 2106.
anodized magnesium (HAE)	magnesium	300 g/L CrO_3	Immerse at room temperature, rinse, dry, weigh, and repeat until weight loss is less than 3.9 mg/dm^2. Keep piece of commercially pure aluminum in solution but not in contact with magnesium. This procedure appears in Military Standard MIL-M-45202C.
brass	steel	500 g/L CrO_3 50 g/L H_2SO_4	Immerse at room temperature with mild agitation.
cadmium	steel	300 g/L NH_4NO_3	Immerse. This procedure appears in the 1961 issue of British Standard 3382 and the 1986 issue of ISO Standard 2082.
cadmium	steel	20g $Sb2O_3$ in 1L concentrated HCl or 20g Sb_2O_3 in 800 mL concentrated HCl + 200 mL water	Immerse until evolution of gas practically stops. **(2)** This procedure appears in the 1960 issue of British Standard 1706, Appendix B.
cadmium	steel	5 % $(NH_4)S_2O_8$ plus 10 % by volume of concentrated NH_4OH solution	Immersion. **(2)** This procedure appears in the 1986 issue of ISO Standard 2082.
chromate	aluminum	(*1*) $NaNO_2$ (2) 1 part by volume water and 1 part concentrated HNO_3	Immerse in molten NaNO at 326 to 354°C for 2 min, rinse in cold water, immerse in (2) for 30 s at room temperature. This procedure appears in the 1967 issue of Specification B449.
chromate (aged)	aluminum and its alloys	(*1*) 98 % $NaNO_3$ 2 % NaOH	Immerse in *(1)* for 2 to 5 min at 370 to 500°C (Some coatings may require the higher temp.) Rinse in water, immerse in *(2)* for 15 to 30 s at room temperature.
		(2) 1 part by volume 65 to 70 % (m/m) HNO_3 1 part water	This procedure appears in the 1980 issue of ISO Standard 3892. Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods
chromate (fresh)	aluminum and its alloys	1 part by volume water and 1 part 65 to 70 % (m/m) HNO_3	Immerse 1 min at room temperature within 3 h of application of coating. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods
chromate	cadmium or zinc	50 g/L NaCN or KCN 5 g/L NaOH	Dissolve cathodically at 15 A/dm^2 at room temperature. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods
chromium	nickel or steel	12 g/L NaOH	Chromium dissolves anodically at about 20 mA/cm^2. **(3)**
copper	nickel	(*1*) dissolve 200 g Na_2S in 3/4 L water, heat to boiling with 20 g S, dilute to 1 L. (*2*) 20 % NaCN	Immerse in *(1)*. When copper becomes black copper sulfide and begins to peel off, rinse and immerse in 20 % NaCN to dissolve copper sulfide. **(4)**
copper	nickel or steel	500 g/L CrO_3 50 g/L H_2SO_4	Dissolves about 1.2 μm/min. **(3, 5)**
copper	zinc alloys	1 part concentrated HCl + 4 parts water	Dissolves zinc alloy substrate. Cool initial reaction to prevent dissolution of copper. **(4)**
gold	steel, copper, nickel, or Fe-Ni-Co	1 part by volume water, 1 part concentrated HNO_3	Substrate is dissolved by immersion. Heat as required. Keep free of halides. Nickel may passivate: make contact with nickel wire to increase area of the nickel. This procedure appears in the 1985 issue of ISO Standard 4524 ⁄1.
lead-tin alloys	steel		See *terne plate*.
nickel	brass	90 % H_3PO_4	Immerse at 180 to 190°C, do not add water. 2.5 μm nickel dissolves in about 10 min. This procedure appears in the 1965 issue of British Standard 3382, Parts 3 and 4: Appendix F.
nickel	brass	500 g/L CrO_3 50 g/L H_2SO_4	Dissolves brass substrate by immersion at room temperature with mild agitation.
nickel	steel	(*1*) fuming HNO_3 with mild agitation or (2) 1 part fuming 1 part concentrated HNO_3 (3) 10 % CrO_3	Attack of steel is insignificant. Transfer quickly to CrO_3 to remove HNO_3, then rinse with water. Ni dissolves more rapidly in *(2)*. **(3, 6)**
nickel	steel	(*1*) sodium meta-nitrobenzene sulphonate 65 g NaOH 10 g NaCN 100 g water to 1 L (*2*) sodium nitrobenzoic acid 65 g NaOH 20 g NaCN 100 g water to 1 L	Immerse in *(1)* or *(2)* at 75 to 85°C7 μm nickel dissolves in about 30 min and dissolves copper undercoat. See British Standard 3382, Parts 3 and 4: 1965: Appendix F.
nickel or nickel over copper	zinc alloys	1 part concentrated HCL + 4 parts water	Dissolves zinc alloy substrate. Cool initial reaction to prevent dissolution of copper. Check for dissolution of nickel. To remove copper from nickel, see copper on nickel. **(4)**

TABLE A1.1 *Continued*

Coating	Substrate	Reagents	Remarks—Sources
phosphate (amorphous)	aluminum and its alloys	1 part by volume water and 1 part 65 to 70% (m/m) HNO_3	Immerse 1 min at room temperature. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods
phosphate (crystalline)	aluminum and its alloys	65 to 70% (m/m) HNO_3	Immerse 5 min at 75 ± 5°C or 15 min at room temperature. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods
phosphate	cadmium or zinc	20g $(NH_4)_2Cr_2O_7$ in 25 to 30 % (m/m) NH_4OH	Immerse 3 to 5 min at room temperature. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods.
phosphate	steel	20 g/L Sb_2O_3 in concentrated HCl	Immerse at room temperature. Rub off any loose material. This procedure appears in the 1973 issue of British Standard 3189, Appendix E.
phosphate (manganese, zinc, or iron base)	steel	50 g/L CrO_3	Immerse at least 15 min at 75 ± 5°C, rinse, dry, weigh, and repeat until weight is constant. See standard DOD-P-16232F. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods.
phosphate (zinc base)	steel	100 g/L NaOH 90 g/L EDTA tetra sodium salt 4 g/L triethanolamine	Immerse 5 min at 70 ± 5°C. This procedure appears in the 1980 issue of ISO Standard 3892, Conversion Coatings on Metallic Materials—Determination of Coating Mass per Unit Area—Gravimetric Methods.
phosphate (zinc base)	steel	180 g/L NaOH 90 g/L NaCN	Immerse at least 10 min, rinse, dry, weight, and repeat until weight is constant. This procedure appears in Department of Defense Standard DOD-P-16232F.
silver	nickel brass	19 parts by volume concentrated H_2SO_4 1 part by volume concentrated HNO_3	Immerse at 80°C. This procedure appears in Federal Specification RR-T-51D.
silver	copper alloys	(*1*) 19 parts by volume concentrated H_2SO_4 1 part by volume concentrated HNO_3 (*2*) concentrated H_2SO_4	Immerse at 60 to 70°C until silver dissolves, dip in concentrated H_2SO_4, rinse. This procedure appears in British Standard 3382, Parts 5 and 6: 1967: Appendixes H and K. See the 1985 issue of ISO Standard 4522/1.
silver	nickel and steel	90 g/L NaCN 15 g/l NaOH	Dissolve anodically at 2–6 V. This procedure appears in the 1985 issue of ISO Standard 4522⁄1.
silver	corrosion-resisting steel and tin alloys	30 g/L NaCN	Dissolve anodically at 3 to 4 V. See Federal Specification RR-T-51D and the 1985 issue of ISO Standard 4522⁄1.
terne plate	long terne sheet	(*1*) 100 g/L NaOH (2) 1 volume concentrated HCl + 3 volume water	Strip anodically in NaOH solution, 77 to 88°C, 12 A/dm^2, reverse current 5 to 15 s, rinse, dip in HCl solution for 1 to 2 s, rinse. See Test Method A309.
terne plate	long terne sheet	200 g/L $AgNO_3$	Immerse, silver replaces terne metal, remove by scrubbing in water and examine for residual terne metal. This procedure appears in the 1981 issue of Test Method A309.
tin	copper alloys	concentrated HCl	Immerse and simmer until tin is dissolved. This procedure appears in British Standard 3382, Parts 5 and 6: 1967: Appendixes H and K.
tin	copper or brass	20 g/L Sb_2O_3 in concentrated HCl	Immerse. This procedure appears in the 1964 issue of British Standard 1872, Appendix A and the 1973 issue of ISO Standard 2093, Annex B.
tin	steel	40 % NaOH	Immerse and heat until gas evolution stops.
tin	steel	120 g $SbCl_3$ in 1 L concentrated HCl	Immerse until evolution of gas stops and then wait 15 to 30 s. This procedure appears in Federal Test Method Standard No. 151b.
tin	steel	20 g Sb_2O_3 in 1 L concentrated HCl	Immerse until 1 min after evolution of gas stops. **(7)** This procedure appears in the 1973 issue of ISO Standard 2093, Annex B.
tin-lead alloy	copper	10 mL concentrated HNO_3 15 g urea 10 mL H_2O_2 (10 volume) 80 mL water	Alloy dissolves at about 0.1 µm/min. Copper dissolves at about 0.5 mg/dm^2/min. **(8)**
tin-nickel alloy	copper and copper alloys	concentrated H_3PO_4	Immerse at 180 to 200°C. See British Standard 3597: 1963: Appendix B.
tin-nickel alloy	steel	20 g/L NaOH 30 g/L NaCN	Dissolve anodically at near-boiling temperature. If current density is too high, coating passivates and gas is evolved. To reactivate, make cathodic for a few seconds. This procedure appears in the 1963 issue of British Standard 3597, Appendix B.
zinc	steel	(*1*) 20 g Sb_2O_3 or 32 g $SbCl_3$ in 1 L concentrated HCl (2) 5 mL of *(1)* in 100 mL concentrated HCl	Immerse in solution *(2),* keep below 38°C until violent evolution of hydrogen has stopped and only a few bubbles are being evolved. This procedure appears in the 1981 issue of Test Method A90/A90M.
zinc	steel	20 g Sb_2O_3 800 mL concentrated HCl 200 mL water	Immerse until effervescence ceases. See British Standard 1706: 1960: Appendix B and the 1986 issue of ISO Standard 2081.
zinc	steel	3.2 g $SbCl_3$ or 2 g Sb_2O_3 in 500 mL	Immerse until vigorous reaction virtually ceases. Brush off loose deposits.

TABLE A1.1 *Continued*

Coating	Substrate	Reagents	Remarks—Sources
		concentrated HCl water to 1 L	This procedure appears in the 1971 issue of British Standard 729, Appendix.
zinc	steel	1-to-1 HCl	Immerse in 1-to-1 HCl until violent evolution of hydrogen has stopped and only a few bubbles are being evolved. Keep below 38°C. This procedure appears in the 1981 issue of Test Method A90/A90M.
zinc	steel	ammonium persulfate 5 g ammonium hydroxide (sp. gr. 0.880) 10 mL water 90 mL	Immerse. This procedure appears in the 1961 issue of British Standard 3382.
zinc	steel	10 mL formaldehyde 30 % (m/m) 500 mL conc HCl 500 mL water	Immerse. This procedure appears in the 1986 issue of ISO Standard 2081.
zinc	steel	300 g/l NH_4NO_3	Immerse. This procedure appears in the 1986 issue of ISO Standard 2081.
zinc	steel	500 mL conc HCl 1 g propin-2-ol-1 (C_3H_4O) 500 mL water	Immerse. This procedure appears in the 1986 issue of ISO Standard 2081.

[A] The boldface numbers in parentheses refer to the list of references at the end of this guide.

REFERENCES

(1) *Standards for Anodically Coated Aluminum Alloys for Architectural Applications,* The Aluminum Association, Second Edition, June, 1965.

(2) Clarke, S. G., "Tests of Thickness of Protective Cadmium Coatings on Steel," *Journal of Electrodepositor's Technical Society*, Vol VIII, 1932–33, p. 11.

(3) Brenner, A., *Monthly Review (AES),* Vol XX, November 1933, p. 7.

(4) Brown, H. E., *Plating,* Vol 38, 1951, p. 556.

(5) Read, H. J., Lorenz, F. R., *Plating,* Vol 38, 1951, p. 946.

(6) Read, H. J. and Lorenz, F. R. *Plating*, Vol 38, 1951, p. 255.

(7) Clarke, S. G., "A Rapid Test of Thickness of Tin Coatings on Steel Analyst," Vol 59, 1934, p. 525.

(8) Price, J. W., "Determination of Thickness of Tin-Lead Alloy Coatings on Copper Wire," *Journal of Society of Chemical Industry*, Vol 63, No. 10, 1944. (Also reprinted as Leaflet No. 13, Tin Research Institute.)