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Standard Specification for Hot Tin and Hot Tin/Lead Dip on Ferrous and Non-Ferrous Metals[1]

This standard is issued under the fixed designation A1074; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers tin and tin/lead coatings applied by the hot dip process on ferrous and non-ferrous metals. hot tin and tin/lead coatings are used to provide a low contact-resistance surface, to protect against corrosion, to facilitate soldering, to provide anti-galling properties, and to be a stop-off coating in the nitriding of high-strength steels.

1.2 This specification is intended to be applicable to items that are reflowed, centrifuged or otherwise handled to remove excess tin or tin/lead bath metal. Coating thickness grade requirements reflect this.

1.3 Some corrosion can be expected from tin or tin/lead coatings exposed outdoors. In normal indoor exposure, tin or tin/lead is protective on iron, steel, nickel, copper, and their alloys. Corrosion can be expected at discontinuities in the coating (such as pores) due to galvanic couples formed between the tin or the tin/lead and the underlying metal through the discontinuities, especially in humid atmospheres.

1.4 This specification applies to hot tin dip coatings of not less than 99.8 % tin and to hot tin/lead dip coatings of 60 ± 5 % tin and the balance lead.

1.5 This specification does not apply to electrodeposited coatings of tin or tin/lead.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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]

A902 Terminology Relating to Metallic Coated Steel Products
B32 Specification for Solder Metal
B183 Practice for Preparation of Low-Carbon Steel for Electroplating
B242 Guide for Preparation of High-Carbon Steel for Electroplating
B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings
B320 Practice for Preparation of Iron Castings for Electroplating
B322 Guide for Cleaning Metals Prior to Electroplating
B339 Specification for Pig Tin
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
B558 Practice for Preparation of Nickel Alloys for Electroplating
B567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method
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
B659 Guide for Measuring Thickness of Metallic and Inorganic Coatings
B678 Test Method for Solderability of Metallic-Coated Products

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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.

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
B851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Autocatalytic Nickel, or Chromium Plating, or as Final Finish
D3951 Practice for Commercial Packaging

3. Terminology

3.1 *Definitions:*

3.1.1 The following terms and definitions are specific to this specification. Many of the terms used in this specification are defined in Terminologies A902 and B374.

3.1.2 *sectional, n*—screen section for placing articles into the hot tin dip so that the articles do not stick together

3.1.3 *significant surface, n*—the portion of the surface of a coated article at which the coating is required to meet all of the requirements of the coating specification for that article. 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 shall be indicated on the drawing of the parts or by the provision of suitably marked samples.

3.1.4 *undercoat, n*—also call an underplate in the electronics/plating industry (see 3.1.5).

3.1.5 *underplating, n*—application of a metallic coating layer between the base metal or substrate and the topmost metallic coating or coatings. The thickness of such an undercoating is usually greater them 50 microinches. This is in contrast to strikes or flashes, whose thicknesses are generally much smaller.

4. Ordering Information

4.1 In order to make the application of this specification complete, the purchaser must supply the following information to the seller in the purchase order and drawings:

4.1.1 Title, ASTM designation number, and year of issue of this specification;

4.1.2 Coating thickness requirement;

4.1.3 Composition and metallurgical condition of the substrate to be coated;

4.1.4 Additional underplate, if required;

4.1.5 Location of significant surfaces;

4.1.6 Hydrogen embrittlement relief, if required; and

4.1.7 Any other items needing agreement between purchaser and coater.

5. Materials and Manufacture

5.1 The specification, grade, or designation and type as well as the degree of surface contamination of the substrate material shall be supplied by the purchaser to the hot tin dip coater prior to coating.

5.2 The design and fabrication of the product to be hot tin dip coated are the responsibility of the designer and the fabricator. Consultation between the designer, the fabricator, and the coater at appropriate stages in the design and fabrication process will reduce future problems.

5.3 The tin used in the hot tin dip process shall conform to Specification B339 and shall not be less than 99.8 % pure tin.

5.4 The tin/lead used in the hot dip tin/lead process shall conform to Specification B32 and shall contain 60 % ± 5 % tin and the balance lead.

5.5 The metal substrate shall be subject to such surface preparation, cleaning, underplating, and hot tin dip procedures as are necessary to yield deposits with the desired quality. Careful preparation of metal surfaces is necessary in order to assure good adhesion and quality. For suitable methods, see Practices B183, B242, B281, B320, B322, and B558.

5.6 Hot tin dip or hot tin/lead dip shall be applied after all basis metal heat treatments, mechanical operations, proper cleaning, and undercoats (if applicable) have been completed.

6. Coating Requirements

6.1 The appearance of the coated product shall be uniform throughout, insofar as the base metal will permit. The finish shall be adherent and visually free from uncoated areas, blisters, flux deposits, dross inclusions, pits, peeled areas, cracks, nodules and other types of projections that would interfere with the intended use of the articles, or other defects not consistent with good hot tin dip or hot tin/lead practice. They shall not be stained or discolored and free of dewetted areas and beads. All surfaces shall be free of grease or oil used in the process.

6.2 The hot tin dip or hot tin/lead dip coating shall be smooth and reasonably uniform in thickness. Smoothness of surface is a relative term. Minor roughness that does not interfere with the intended use of the part, or roughness that is related to the as-received surface condition of the part, shall not be grounds for rejection.

NOTE 1—Since this specification is applicable to items that are centrifuged and reflowed to remove excess bath metal (see 1.2), irregular coating distribution is not normally encountered.

6.3 The hot tin dip or hot tin/lead dip coating shall adhere tenaciously to the surface of the base metal or undercoat (undercoat as required, requested or needed to facilitate adhesion, suppress migration of tin into base metal or other).

6.4 If the hot tin dipped or hot tin/lead dipped material covered by this specification is bent or otherwise fabricated to the degree that causes the coating to stretch or compress beyond the limit of elasticity, any cracking or flaking of the coating resulting from the post coating bending or fabricating shall not be cause for rejection.

6.5 All hot tin dip or hot tin/lead dip articles shall be clean and undamaged. When necessary, preliminary samples showing the finish shall be supplied to and approved by the purchaser.

6.6 *Thickness of Coating*—Where hot tin dip and hot tin/lead dip are molten processes, the thickness of coating can not be built up in excess. After centrifuge and/or reflowing of the

articles, the mean value for finished thickness will range from 100-300 microinches. This range yields a smooth, solderable finish.

6.7 *Underplating*

6.7.1 For substrates of steel, brass, and other copper alloys, the hot tin dip or hot tin/lead dip finish can be applied directly onto the base metal.

6.7.2 To prevent zinc migration and impairment of solderability during service or storage, substrates of brass or other copper alloys must have a copper undercoating of at least 100 microinches, or a nickel undercoating of at least 50 microinches prior to hot tin or hot tin/lead dipping. A thicker coating of nickel may be required in some situations for additional retardation and improved adhesion.

6.7.3 Other substrates such as aluminum, stainless steel, and kovar must have an electroless nickel coating undercoating in order for hot dipped coatings to adhere properly.

6.8 *Hydrogen Embrittlement Relief*—High-tensile strength steels and severely cold worked steels are susceptible to embrittlement by hydrogen in both cleaning and hot tin and hot tin/lead dipping. See Supplementary Requirements for details.

7. Sampling

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

7.2 The procedure for sampling is accomplished by selecting a relatively small number of the finished articles at random. These articles (the inspection lots) are inspected and classified as complying or not complying with the requirements of the specification. The size of the sample and the criteria of compliance are determined by the application of statistics. The procedure is known as sampling inspection. The sampling plan can be selected by following the guidelines in Guide B697. These standards, Test Method B602, Test Method B762, MIL-STD-105, and MIL-STD- 1916, contain sampling plans that are designed for the sampling inspection of coatings.

7.3 An inspection lot shall be defined as a collection of coated articles that meet the following requirements: they are of the same kind; have been produced to the same specifications; have been coated by a single supplier at one time, or at approximately the same time, under essentially identical conditions; and are submitted for acceptance or rejection as a group.

7.4 *Special Test Specimens*—It may be preferable to use special test specimens to represent product in process control or in acceptance inspection when, for example, destructive tests are used and it is desirable not to destroy product or if the test specimen is better adapted to the test. The use of special test specimens, their number, the material for which they are made, their size and shape, and the conditions of their coating shall be agreed upon by the purchaser and the seller.

8. Tests

8.1 *Deposit Purity*—Atomic absorption or energy dispersion spectrophotometry, or any other method with a demonstrated uncertainty of less than 10 % of the component measured, may be used to determine The quantity of impurities in the tin or tin/lead baths. Initial scanning should be conducted for all elements in order to detect any unknown or unexpected impurities. Determine deposit purity by subtracting the total quantity of impurities from 100 %.

8.1.1 Deposit purity is best determined on samples of the actual product. If special test specimens are used, care must be taken to arrange the specimens so as to hot tin dip or hot tin/lead dip them under the same conditions as typical production pieces.

8.2 *Thickness*—The coating thickness shall be measured at locations on significant surfaces by one of the following test methods: Test Methods B487, B499 (magnetic substrates only), B504, B567, or B568. Practice B659 may be consulted to determine the most appropriate test method.

8.3 *Adhesion*—Adhesion of the coating is not normally tested on each lot of samples but, if there is an issue with adhesion then samples shall be tested by one of the recommended methods of Practice B571 or other method agreed to by the purchaser and the supplier.

8.4 *Solderability*—For coatings that must be solderable, the method by which solderability is tested shall be agreed to by the purchaser and the supplier. A simple dip test is given in Test Method B678, while two other methods are described in Appendix X1. The purchaser shall specify whether the test articles are to receive an artificial aging treatment, such as that given in Test Method B678, so as to demonstrate whether the articles may be expected to retain solderability during long storage periods

9. Inspection

9.1 The inspector representing the purchaser shall have access at all times while work on the contract of the purchaser is being performed, to those areas of the manufacturer's work which concern the application of the hot tin dip or hot tin/lead coating to the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the hot tin coating is being furnished in accordance with this specification. All inspection and tests shall be made at the place of manufacture prior to shipments, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

10. Rejection

10.1 Articles that fail to conform to the requirements of this specification may be rejected. Rejection shall be reported to the seller promptly and in writing. In case of rejection, the seller may strip and recoat the products and resubmit them for inspection. Parts rejected for embrittlement may not be stripped and recoated.

11. Packaging

11.1 The supplier shall employ such methods of packaging hot tin coated articles as shall be required to ensure their receipt by the purchaser in satisfactory condition, with the use to be made of the article being taken into consideration.

11.2 Parts plated for the U.S. government and military, including subcontractors, shall be packaged in accordance with Practice D3951.

NOTE 2—Some contemporary packaging materials may emit fumes that are deleterious to the surface of the coating.

12. Keywords

12.1 centrifuge; hot tin dip; hot tin plated; metallic coated; tin coatings; reflow

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the contract or order.

Pretreatment of Iron or Steel for Reducing the Risk of Hydrogen Embrittlement

S1.1 Parts for critical applications 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 head treatment, shall require stress relief treatment when specified by the purchaser, the tensile strength to be supplied by the purchaser.

Specifications B849 (heat treatment) and B851 (shot peening) may be consulted for a list of pretreatments that are used widely.

APPENDIXES

(Nonmandatory Information)

X1. SOLDERABILITY TESTS

X1.1 Wetting Time

X1.1.1 Methods for testing the solderability of hot tin coated articles are base on measurement of the extent of wetting by molten solder or determination of the minimum time required to produce full or perfect wetting by the solder.

X1.1.2 The extent of wetting can be observed by simple immersion in solder under controlled conditions, or by performing dip tests with automated equipment. Visual examination, time of wetting, measurement of area of spread, and calculation of spread values are used to assess solderability.

X1.1.3 The minimum wetting time is determined by carrying a specimen in a fixture through a standing wave of solder at a controlled speed and measuring the time of immersion required to achieve complete wetting.

X1.2 Wetting Balance

X1.2.1 The wetting balance provides the most objective, operator-independent, and reproducible measure of the solderability of a surface of currently known methods. Numerous models are available under different names such as the surface-tension balance, and trade names, such as “menisco-graph,” but all share certain common features.

X1.2.2 The base structure holds a heated solder bath that can be raised or lowered at a specific rate. The test piece is held in clamp that extends from an arm directly over the solder bath. The clamp is attached to a load cell and to a transducer, with transmits a signal to a converter that adjusts the signal to a useful mode (analog or digital) for the recording instrument, computer, or strip-chart recorder.

X1.2.3 The parameters of the test are set on the instrument, according to the manufacturer’s instructions, to reveal the most information concerning the solderability of the test piece.

X1.2.4 The bath temperature must be held within precise limits at a suitable temperature with respect to the solder alloy. The immersion rate, which may vary from 1 to 25 mm/s, must be constant from sample to sample.

X1.2.5 The immersed surface area of the standards and samples should be similar, as well as the depth of immersion and the type and weight of flux on the test piece.

X1.2.6 Opposing forces of buoyancy and wetting, versus time, which are transmitted from the transducer to the strip-chart recorder or the computer during the test, are plotted.

X1.2.7 The most significant information obtained from the graph are the wetting time, rate of wetting, total wetting force, and whether the wetting force remains constant over the time of the test.

X1.2.8 Test samples are to be run against a series of standards that have been run to establish averages and to define precision windows. The goal is to define minimum acceptable solderability in terms of a maximum wetting time, minimum wetting rate, minimum force, and stable wetting at a set dwell time.

X2. WETTING TERMINOLOGY

X2.1 *De-wetting*— A condition that results when molten metal has coated a surface and then receded, leaving irregularly shaped mounds separated by areas covered with a thin metal finish; base metal is not exposed.

X2.2 *Non-wetting*— A condition whereby a surface has contacted molten metal, but the metal has not adhered to all of the surfaced; base metal remains exposed.

X2.3 *Wetting*— The formation of a relatively uniform, smooth, unbroken, and adherent film of the metal coating to a base metal.

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