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Standard Guide for Preparation of Lead and Lead Alloys for Electroplating[1]

This standard is issued under the fixed designation B319; 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 guide provides methods for preparing lead or lead alloy products for the application of electroplated or autocatalytic coatings.

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

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings

3. Significance and Use

3.1 The preparation of lead and lead-alloy surfaces for electroplating is often critical to the successful performance of electrodeposited and autocatalytic metallic coatings.

3.2 This standard outlines the process operation procedures and processing solutions required, that lead to satisfactory electrodeposited metallic coatings (including undercoating) on surfaces of lead and lead-alloys.

4. Nature of Lead

4.1 The tensile strength of lead and lead alloys ranges from 15 to 35 MPa (2000 to 5000 psi), therefore, the measured adhesion of electroplated coatings cannot be greater than these values.

4.2 Difficulties in applying high-quality electroplated coatings to lead are due to the following properties of lead:

4.2.1 The very active chemical nature of lead, leading to the formation of oxide films in air,

4.2.2 The fact that the lead surface will form films of insoluble lead salts with most acids used in pickling,

4.2.3 The ease with which lead diffuses in contact with nonferrous metals, and

4.2.4 The poor resistance to plastic deformation during polishing.

5. Process Precautions

5.1 The following process precautions should be observed:

5.1.1 Precleaning of raw castings is sometimes necessary to remove mold parting compounds, surface oxides, and residues from recessed areas which are never reached by polishing-wheel or scratch-brush operations (Section 6).

5.1.2 In high-speed type cyanide electroplating solutions, the initial current density must be controlled and kept low enough so that no gassing occurs to cause poor adhesion. This is revealed as groups of blisters in the high-current-density areas of the electroplate.

5.1.3 If a strike electroplate is used, it should be thick enough to prevent the next electroplating solution from attacking the basis lead. A copper or nickel strike 2.5 µm thick should be used, but because there are so many variables involved, no specific recommendations can be made.

5.1.4 Preplates should be of such thickness that complete alloying with the lead does not take place, an occurrence that causes poor adhesion of subsequent deposits. This defect is indicated by blistering after prolonged storage or after an accelerated aging test.

5.1.5 The lead compounds formed by the action of acids and alkalies most often used in electroplating are not water soluble. Caution must be taken to remove or prevent the formation of these to eliminate subsequent adhesion failure. Acids that

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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.

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cannot be used are sulfuric, hydrochloric, and hydrofluoric. (Acids that can be used are sulfamic and fluoboric.) Alkalies should not be high in caustic content. Mild or buffered cleaners are preferred in order to minimize attack on the basis lead surface.

5.1.6 Engraving of electroplated finishes on lead cannot be performed on deposits over 5 µm thick as the deposit will tear away from the lead at cross cuts. Engine turning by burnishing can be done on any thickness of deposits.

5.1.7 Polishing and coloring of the deposit must be performed at slow speeds, and with loose or cooled buffs to eliminate overheating and flowing of basis metal.

6. Precleaning

6.1 Remove fins and parting lines by use of trimming dies or by scraping, filing, or grinding. Some machining may be done at this point, such as drilling holes, or milling or cutting slots, groove, flats, or squared surfaces.

6.2 Clean in alkaline, emulsion type, or other standard cleaning material to remove surface materials (5.1.5).

6.3 After rinsing, transfer the parts into one of the following pickling solutions, the function of which is to remove surface oxides, without significant attack on the lead surface.

6.3.1 An aqueous solution containing 250 mL of 48 mass %, fluoboric acid with or without 45 mL of 30 mass % hydrogen peroxide diluted to 1 L. The addition of hydrogen peroxide will increase the aggressiveness of the pickling solution.

6.3.2 An aqueous solution containing 80 mL of glacial acetic acid and 45 mL of 30 mass % hydrogen peroxide diluted to 1 L.

6.3.3 An aqueous solution containing 100 g of sulfamic acid diluted to 1 L.

NOTE 1—These pickling solutions should be held in tanks having suitable nonmetallic linings.

6.4 After rinsing, an immersion in a water-displacing, film-forming material is advantageous. Sometimes a neutral soap, oil, or synthetic emulsion film may be used according to the type of polishing compound to be used. These materials are removed in subsequent operations.

7. Assembly of Parts

7.1 Precleaned parts then are ready for further assembly, such as soldering to other metals for ornamentation or mechanical reasons.

8. Polishing or Buffing

8.1 After parting lines, fins, and gate marks are removed, greaseless compounds on loose cloth wheels are used for rough smoothing followed by a soft leather, chamois, or sheepskin wheel operating at 15 to 25 surface m/s. These are used with white lime compounds of various grease concentrations. Cloth wheels can be used on highly ornamented parts, but not on any surface having a smooth area, as drag marks will occur.

9. Preparation for Electroplating

9.1 *Precleaning:*

9.1.1 Solvent or solvent emulsion cleaners can be used if the parts can be rinsed easily and completely; otherwise alkaline cleaners and ammonia, or wetting agent soaks should be used. Spray washing with alkaline or solvent-type cleaners may be used before the electrocleaning cycle instead of soak cleaning.

9.2 *Electrocleaning:*

9.2.1 Cathodic electrocleaning usually is used, especially for decorative bright finishes. Anodic electrocleaning dissolves the lead and is used sometimes in industrial or special applications if stressed or distorted surface layers must be removed to expose the natural understructure.

9.2.2 There are proprietary cleaners designed for special conditions; however, a cleaner made up using 23 g/L of sodium carbonate and 23 g/L of trisodium orthophosphate, anhydrous operated at 60 to 80 °C with 6 to 8 V with the work cathodic for 30 to 60 s is advantageous. Hand cleaning by mopping and brushing is performed, but the trend is away from hand operations.

9.3 *Acid Pickle:*

9.3.1 An acid pickle of one of the following types is used to remove all oxide residues and insoluble compounds left from cleaning:

9.3.1.1 An aqueous solution containing 120 to 250 mL of 48 mass % fluoboric acid diluted to 1 L used at 20 to 25 °C for 30 to 60 s. See Practice B281.

9.3.1.2 An aqueous solution containing 100 g of sulfamic acid dissolved in water and diluted to 1 L used at 20 to 25 °C for 30 to 60 s. A blend of 75 to 85 % by weight sulfamic acid and 15 to 25 % by weight ammonium bifluoride may be dissolved in water at 60 to 120 g/L to form an equivalent solution.

10. Typical Cycles

10.1 *Stereotype Metal (80 to 84 % Lead, 11 to 13 % Antimony, 4 to 6 % Tin)*

10.1.1 *Preparation for Nickel or Iron Stereotypes:*

10.1.1.1 Electroclean cathodically and then anodically with the following solution or a proprietary equivalent:

Solution	60 to 90 g/L trisodium orthophosphate crystals ($Na_3PO_4 \cdot 2H_2O$)
Temperature	40 °C
Voltage	6 V
Cathodic	3 to 4 min
Anodic	up to 10 s
Current density	3 A/dm^2

10.1.1.2 Cold water rinse and spray.

10.1.1.3 Acid dip with the following solution:

Solution	25 volume % of 42 % fluoboric acid
Temperature	20 to 25 °C
Time	10 to 15 s

10.1.1.4 Cold water rinse and spray.

10.1.1.5 Nickel or iron electroplate, 20 µm thick.

NOTE 2—A small amount of current must be applied prior to and while the article is entering the plating solution. After entry, the current should be adjusted to its normal value. Additionally, a nickel strike (see Table X1.1) may be used prior to the nickel or iron electroplate.

10.1.2 *Alternative Preparation for Iron Electroplating Stereotypes:*

10.1.2.1 Vapor degrease or wash in Stoddard solvent to remove proof-printing ink.

10.1.2.2 Electroclean (see 10.1.1.1).

10.1.2.3 Scrub with tampico brush and cleaning solution used in 10.1.2.2.

10.1.2.4 Thoroughly rinse with water.

10.1.2.5 Acid dip as in 10.1.1.3 (see 9.3.1, section 9.3.2, and section 9.3.3).

10.1.2.6 Thoroughly rinse with water.

10.1.2.7 Iron electroplate, 20 µm thick. (See 10.1.1.5.)

NOTE 3—The iron may be electrodeposited from the following solution:

Ferrous ammonium sulfate ($FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$)	340 g /L
Boric acid (H_3BO_3)	40 g/L
pH	3.1 to 3.4 (adjusted with sulfuric acid)
Temperature	60 °C
Current density	1 to 5 A/dm^2

11. Decorative Applications

11.1 *Preparation for Copper Striking:*

11.1.1 Preclean and water rinse (see 9.1).

11.1.2 Electroclean (see 9.2).

11.1.3 Water rinse.

11.1.4 Dip in acid (see 9.3).

11.1.5 Thoroughly water rinse.

11.1.6 Cyanide copperstrike to give complete coverage (see Table X1.3). Other proprietary copper strikes may be used.

11.1.7 Water rinse thoroughly to remove all traces of cyanide.

11.1.7.1 Prior to further electroplating, use a 1 to 2 % sulfuric acid rinse.

11.1.8 Follow with other electrodeposits as required.

11.2 *Preparation for Nickel Striking:*

11.2.1 Preclean and water rinse (see 9.1).

11.2.2 Electroclean (see 9.2).

11.2.3 Water rinse.

11.2.4 Acid dip (see 9.3).

11.2.5 Water rinse.

11.2.6 Nickel strike to give complete coverage (see Table X1.1 and Table X1.2).

11.2.7 Water rinse.

11.2.8 Follow with other electrodeposits as required.

12. Small Parts

12.1 *Preparation for Barrel Plating:*

12.1.1 See Section 6 for precleaning steps.

12.1.2 Acid dip (see 9.3).

12.1.3 Thoroughly water rinse.

12.2 Cyanide copperstrike to give complete coverage (see Table X1.3). Other proprietary copper strikes may be used.

12.2.1 Water rinse thoroughly to remove all traces of cyanide.

12.2.2 Prior to electroplating, use a 1 to 2 % sulfuric acid rinse.

APPENDIX

(Nonmandatory Information)

X1. STRIKE SOLUTIONS

X1.1 Table X1.1, Table X1.2, and Table X1.3 contain the composition of the solutions and the operating conditions for nickel and copper strikes.

TABLE X1.1 Nickel Sulfamate Strike Solution

	Quantity, g/L
Nickel sulfamate, $Ni(SO_3NH_2)_2)$	250
Nickel chloride ($NiCl_2 \cdot 6H_2O$)	25
Boric acid (H_3BO_3)	30
pH	3.5
Temperature	30 to 35 °C
Current density	1 to 2 A/dm^2

TABLE X1.2 Nickel Fluoborate Strike Solution

	Quantity, g/L
Nickel fluoborate ($Ni(BF_4)_2$)	250
Boric acid (H_3BO_3)	30
pH (paper)	3.5
Temperature	30 to 60 °C
Current density	1 to 2 A/dm^2

TABLE X1.3 Copper Strike Solution

	Quantity, g/L
Copper cyanide (CuCN)	22.5
Sodium cyanide (NaCN)	40
Sodium carbonate (Na_2CO_3)	15
Total copper (Cu)	16
Free cyanide (CN^-)	15
Temperature	40 to 50 °C
Current density	1 to 1.5 A/dm^2

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