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Standard Practice for
Preparation of Plastics Materials for Electroplating[1]

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1. Scope

1.1 This practice is a guide to the surface preparation of plastic materials for decorative and functional electroplating, where the sequence of chemical treatments may include: cleaning, conditioning, etching, neutralizing, catalyzing, accelerating, and autocatalytic metal deposition. Surface preparation also includes electrodeposition of metallic strike coatings immediately after autocatalytic metal deposition. These treatments result in the deposition of thin conductive metal films on the surface of molded-plastic materials, and are described in this practice.

1.2 Once molded-plastics materials have been made conductive, they may be electroplated with a metal or combination of metals in conventional electroplating solutions. The electroplating solutions and their use are beyond the scope of this practice.

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

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.* (See Section 4.)

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B532 Specification for Appearance of Electroplated Plastic Surfaces
B533 Test Method for Peel Strength of Metal Electroplated Plastics
B553 Test Method for Thermal Cycling of Electroplated Plastics[3]
B604 Specification for Decorative Electroplated Coatings of Copper Plus Nickel Plus Chromium on Plastics

3. Significance and Use

3.1 A variety of metals can be electrodeposited on plastics for decorative or engineering purposes. The most widely used coating consists of three layers—copper plus nickel plus chromium—for decorative applications. However, brass, silver, tin, lead, cadmium, zinc, gold, other metals, and combinations of these are used for special purposes. The key to producing electroplated plastics of high quality lies in the care taken in preparing plastics for electroplating. The information contained in this practice is useful in controlling processes for the preparation of plastics for electroplating.

4. Hazards

4.1 Some chemical solutions are exothermic upon mixing or in use, thereby requiring cooling and proper containment to prevent injury to personnel.

4.2 For details on the proper operation and safety precautions to be followed by vapor degreasing, see ASTM STP 310.[4]

5. General Considerations

5.1 *Nature of Plastics Suitable for Electroplating*:

5.1.1 Plastics suitable for electroplating may be a combination of one or more polymers so formulated as to allow selective etching of one or more constituents. The most commonly electroplated material, acrylonitrile-butadiene-styrene (ABS), is a terpolymer. During etching, soft butadiene rubber particles dispersed in the acrylonitrile-styrene matrix are selectively attacked. The microscopic pockets formed by the etching process provide sites for the physical interlocking of the plastic substrate and subsequently applied metallic coatings. The resultant mechanical bonding is instrumental in achieving metal to plastic adhesion.

5.2 *Plastics Suitable for Electroplating*:

5.2.1 The plastics materials commonly used for injection molded articles to be electroplated are:

5.2.1.1 Acrylonitrile-butadiene-styrene (ABS),
5.2.1.2 Polypropylene,
5.2.1.3 Polysulfone,
5.2.1.4 Modified Polyphenylene Oxide,
5.2.1.5 Polycarbonate,

[1] This practice is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.02 on Pre Treatment.

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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] Withdrawn.

[4] *Handbook of Vapor Degreasing, ASTM STP 310A,* ASTM, 1976.

5.2.1.6 Polyester, and

5.2.1.7 Nylon.

5.2.2 The preparation of these materials for electroplating generally involves the basic steps described in this practice, but substantial variations may be necessary to achieve optimum results with plastics other than ABS.

5.3 *Molding Considerations*:

5.3.1 The chemical nature of plastics combined with the nature of the injection molding process produces plastic parts that are somewhat heterogeneous in composition and structure. During the molding of ABS, for example, the shape, size, and distribution of butadiene rubber particles may vary considerably within a part and may affect the uniformity of subsequent surface etching treatments. As a result, under- and over-etching of the surface may occur, either of which can interfere with the adhesion of metal coatings. The use of a properly formulated etchant combined with an organic conditioner may overcome problems of nonuniform etching.

5.3.2 Although it may be possible to overcome problems of nonuniform etching by suitable chemical treatments, control of the injection molding process is critical if plastic parts are to be electroplated successfully. It is essential that the resin be thoroughly dried before molding. The temperature of the mold and all heating zones, the pressure, the total cycle time, and the fill time must be controlled and monitored. Devices exist for controlling all molding parameters precisely.

5.3.3 The visible defects that may arise in the molding process are described in Specification B532. Molded parts that are obviously defective should not be processed without the approval of the purchaser.

5.3.4 Mold release agents interfere with the adhesion of metallic coatings on plastic substrates and should not be used.

5.4 *Process Selection*:

5.4.1 Due to the complexity and proprietary nature of commercially available processes for preparing plastics for electroplating, a complete process should be selected for a specific type of plastic, and operated according to the specific instructions of the supplier of the process.

5.5 *Handling of Molded Plastic Parts*:

5.5.1 Molded-plastic parts must be kept clean and carefully handled. It is a common practice to use cotton gloves in removing parts from the mold and for all subsequent handling.

5.5.2 The trimming of plastic parts and the removal of flash and runners should be done with care to avoid introducing surface defects. These and other mechanical finishing operations should be completed before beginning the chemical treatment of parts for electroplating. Runners are sometimes left intact to facilitate racking for electroplating at a later stage.

5.6 *Racking:*[5]

5.6.1 Molded-plastic parts can be prepared for electroplating in barrels, trays, or baskets and then transferred to racks designed specifically for electroplating, or they can be processed on racks that are used in both the preparation and electroplating cycles. Which method of racking to use may be dictated by the size of the parts, by efficiency, and other considerations. The first is the bulk method; the second is called "through-racking."

5.6.2 *Bulk Method*—Small parts are often processed in polypropylene baskets or plastic-coated steel baskets. Somewhat larger parts can be processed in layered baskets made of stainless steel (UNS Types S30400 or S31600), titanium, or plastic-coated mild steel. Parts are placed as closely as possible compatible with the need to provide for complete solution wetting and drainage.

5.6.3 *Through-Racking*:

5.6.3.1 The design of racks to be used in both preparation and electroplating processes is dictated by the requirements of electroplating and the corrosive nature of the solutions.

5.6.3.2 Rack splines and hooks are generally made of copper or copper alloys. Rack cross bars are made of copper or copper alloys if they are to conduct current from the splines to the contacts, but may be made of steel if their function is solely to strengthen and make the rack rigid. Rack contacts are usually stainless steel, although titanium has also been used. If spring action is necessary, phosphor bronze may be used as the contact member with a short stainless steel piece for the tip.

5.6.3.3 The entire rack is sandblasted, primed, and coated with plastisol before use, except for the stainless steel contacts. During the preparation process, the rack coating may become coated with metal, but this does not usually occur because hexavalent chromium is absorbed in the plastisol and prevents autocatalytic metal deposition from occurring.

5.6.3.4 Control of immersion times in neutralizing, catalyzing, and accelerating steps is critical to prevent metal deposition on the rack coating.

5.6.3.5 Parts are positioned on racks to optimize the thickness and appearance of electrodeposited coatings, and to minimize solution dragout.

5.6.3.6 It may be necessary to use current thieves, shields, or auxiliary anodes to obtain uniform metal distribution. The number of contacts is greater for plastic parts than for comparable metal parts. For example, if the total area being electroplated in less than 0.02 m^2, one contact point is usually sufficient; if the area is 0.25 to 0.60 m^2, 16 contact points are recommended.

5.6.3.7 Metal deposited autocatalytically or electrolytically must be chemically removed from contacts after each cycle. This is usually accomplished by using nitric acid-containing solutions, or proprietary rack strippers.

6. Preparation of Plastic Substrates[6]

6.1 *Alkaline Cleaning*:

6.1.1 Cleaning in alkaline solutions is optional. If the parts are carefully handled and kept clean after molding, alkaline cleaning can usually be avoided.

6.1.2 Fingerprints, grease, and other shop soil should be removed by soaking plastic-molded parts in mild alkaline solutions that are commercially available. A suitable solution may contain 25 g/L of sodium carbonate and 25 g/L of trisodium phosphate operated at 55 to 65°C. Parts are immersed in the solution for 2 to 5 min (see Note 1).

[5] *Standards and Guidelines—Electroplated Plastics,* American Society of Electroplated Plastics, Washington, DC, Second Edition, 1979.

[6] Adcock, J. L., "Electroplating Plastics—an AES Illustrated Lecture," American Electroplaters' Society, Inc., Winter Park, FL, 1978.