Designation: D2093 – 03 (Reapproved 2017)

Standard Practice for Preparation of Surfaces of Plastics Prior to Adhesive Bonding[1]

This standard is issued under the fixed designation D2093; 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 practice describes surface preparations for plastic adherends, to be used prior to adhesive bonding of test specimens. It should be noted, however, that this practice specifies only the pretreating conditions of the plastic and does not cover the preparation of test specimens, testing conditions, or evaluation of tests. These are covered in the various ASTM test methods or specifications for specific materials.

1.2 *Physical Treatments* (for example, sanding and solvent wiping) are used in order to remove the glossy finish and all traces of dirt, grease, mold release, or other contaminants from the bonding surfaces.

1.3 *Chemical Treatments* (for example, sulfuric acid—dichromate solution and sodium naphthalene complex) are used in some cases to alter chemically the surface layers of the polymer itself to improve its adhesion characteristics.

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

1.5 *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.* Specific precautionary statements are given in 6.1.

1.6 *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]

D897 Test Method for Tensile Properties of Adhesive Bonds

D903 Test Method for Peel or Stripping Strength of Adhesive Bonds

D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading

D907 Terminology of Adhesives

D950 Test Method for Impact Strength of Adhesive Bonds

D952 Test Method for Bond or Cohesive Strength of Sheet Plastics and Electrical Insulating Materials

D1002 Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)

D1193 Specification for Reagent Water

D3807 Test Method for Strength Properties of Adhesives in Cleavage Peel by Tension Loading (Engineering Plastics-to-Engineering Plastics)

3. Terminology

3.1 *Definitions*—Many terms are defined in Terminology D907.

4. Significance and Use

4.1 This practice is useful for reducing some of the surface variability of plastics (due to differences in manufacturing methods) that might otherwise cause excessive variation in the results of ASTM test methods designed to measure adhesion. The treatments specified are convenient for laboratory work.

4.2 This practice is not necessarily designed to provide optimum adhesion to the surfaces and the treatments specified may not always be practical for industrial use.

[1] This practice is under the jurisdiction of ASTM Committee D14 on Adhesives and is the direct responsibility of Subcommittee D14.40 on Adhesives for Plastics.

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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.

TABLE 1 Physical Treatments

Plastic Adherend (Group I)	Cleaning Procedure
Cellulose acetate, cellulose acetate butyrate, cellulose nitrate, methylstyrene, polycarbonate, polystyrene, vinyl chloride, polymethylmethacrylate, cellulose propionate, ethylcellulose, ABS (acrylonitrile butadiene styrene)	Wipe with methanol, sand, wipe with a clean dry cloth, then repeat methanol wipe at room temperature.
Epoxy, polyester, phenolic, urea-formaldehyde, diallyl phthalate, melamine, nylon, and polyurethane	Wipe with acetone, sand, wipe with a clean dry cloth, then repeat acetone wipe at room temperature.

TABLE 2 Chemical Treatments

Plastic Adherend (Group II)	Cleaning Procedure
Polyolefins (low- and high-density polyethylene, polypropylene, irradiated polyethylene), chlorinated polyether, polyformaldehyde	Wipe with acetone and treat with sulfuric acid-dichromate solution. Treat polyolefins for at least 1 h at room temperature. Treat chlorinated polyether for 5 min at 71 ± 3°C (160 ± 5°F). Treat polyformaldehyde up to 10 s at room temperature.
Trifluoromonochloroethylene, tetrafluoroethylene	Wipe with acetone and treat with sodium naphthalene complex for 15 min at room temperature.

4.3 This practice does not address all of the surface preparation methods available; nor does this practice cite all of the types or classes of plastics currently available.

4.4 This practice is used as a starting point for evaluating surface preparation techniques for plastic adherends prior to adhesive bonding.

5. Apparatus

5.1 *Abrasive, Aluminum Oxide,* 320 grit, free of waxes, lubricants, or other potential contaminants.

5.2 *Glass Dish,* borosilicate, of appropriate dimensions, in which to heat the sulfuric acid-dichromate solution.

5.3 *Hot Plate* to provide a source for heating the acid.

5.4 *Cotton Cloths,* lint-free, clean, white, or non-linting paper wipers.

5.5 *Tongs,* stainless steel.

6. Pretreating Liquids

6.1 *Sodium Naphthalene Solution*—Sodium naphthalene solutions are commercially available.[3] When not in use, keep the solution in a tightly-closed glass container to exclude air and moisture. (**Warning**—Exercise extreme care in preparing, handling, and disposing of both the sulfuric acid-dichromate solution and the sodium naphthalene solution since these are hazardous materials.)

6.2 *Solvents*—Use reagent grade solvents free of any contaminants such as dirt, grease, etc., for cleaning specimens.

6.3 *Sulfuric Acid-Dichromate Solution* (see 7.1.1)—Dissolve 75 g of potassium dichromate ($K_2Cr_2O_7$) in 120 g of clean tap water, then add 1500 g of concentrated sulfuric acid (H_2SO_4, sp gr 1.84) in increments of approximately 200 g, stirring after each addition.

6.4 *Water*—Use clean tap water, at 16 – 38°C (61 – 100°F) to wash specimens.

[3] Acceptable solutions are available from W. S. Shamban and Co., 1855-T Centinela Avenue, Santa Monica, CA 90404 and W. L. Gore Associates, 555 Paper Mill Road, Newark, DE 19711.

7. Procedure

7.1 Use the following surface treatments to prepare the bonding areas of plastic adherends for adhesive test specimens as indicated in Tables 1 and 2.

7.1.1 *Solvent Wiping*—Wipe the bonding surface of each adherend with three successive portions of a clean solvent-dampened cloth (Note 1). Allow the adherends to stand in a clean, dust-free area with bonding surfaces upwards for 20 min to allow evaporation of solvents or condensed humidity.

NOTE 1—Use a fresh portion of cloth and fresh solvent for each wipe. Do not dampen the cloth by placing it in contact with the mouth of the bottle, but by pouring a small amount of solvent onto the cloth.

7.1.2 *Sanding*—Sand the bonding surfaces of the adherends with a fine-grit sandpaper or emery cloth until no evidence of surface gloss is visible (Note 2). Wipe with a clean dry cloth to remove particles from the sanding. Bond the surface as soon after preparation as possible.

NOTE 2—Sanding is desirable in many instances to remove the surface of plastic that may have contaminants, for example, mold release. Roughing due to sanding may also increase the effective bonding area.

7.1.3 *Sulfuric Acid—Dichromate Solution Treatment:*

7.1.3.1 *Room Temperature*—Immerse the plastic adherends in the sulfuric acid-dichromate solution that is maintained at a temperature of 20 to 30°C (68 to 86°F) for the time period given in Table 2. Immediately remove them and rinse thoroughly under running tap water for at least 3 min, followed by a distilled or deionized water rinse in accordance with Specification D1193, Type IV. Dry by placing, bonding side up, in an air-circulating oven at 37 ± 3°C (99 ± 5°F) for about 1 h. Do not wipe the surface during or after treatment.

7.1.3.2 *Elevated Temperature*—Immerse the plastic adherends in a sulfuric acid—dichromate solution that is maintained at a temperature of 71 ± 3°C (160 ± 5°F) for the time period given in Table 2. Immediately remove them and rinse thoroughly in running tap water for at least 3 min followed by a distilled or deionized water rinse in accordance with Specification D1193, Type IV. Dry in an air-circulating oven at 37 ± 3°C (99 ± 5°F) for about 1 h.

7.1.4 *Sodium Naphthalene Complex Treatment*—Immerse the adherends in the liquid for 15 min at room temperature.

Remove them from the solution with metal tongs, wash in acetone to remove excess organic materials, and subsequently wash with distilled or deionized water (Specification D1193, Type IV) to remove the last traces of metallic salts from the treated surfaces. Before bonding dry the treated adherends in an air-circulating oven at 37 ± 3°C (99 ± 5°F) for about 1 h.

8. Keywords

8.1 adhesive bonding; plastic; surface preparation