Designation: D2510 – 94 (Reapproved 2012)

Standard Test Method for Adhesion of Solid Film Lubricants[1]

This standard is issued under the fixed designation D2510; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method[2] covers the measurement of the adhesion characteristics of dry solid film lubricants.

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

1.3 *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:*[3]

B209M Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

D1000 Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

D1193 Specification for Reagent Water

D1730 Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting

D3330/D3330M Test Method for Peel Adhesion of Pressure-Sensitive Tape

F22 Test Method for Hydrophobic Surface Films by the Water-Break Test

2.2 *U.S. Military Specification:*[4]

MIL-L-46010

3. Terminology

3.1 *Definitions:*

3.1.1 *dry solid film lubricants, n*—dry coatings consisting of lubricating powders in a solid matrix bonded to one or both surfaces to be lubricated.

4. Summary of Test Method

4.1 The dry solid film lubricant is applied to anodized aluminum panels, immersed in water or other fluids for 24 h, and then wiped dry. A strip of masking tape is pressed onto the panel and removed abruptly. Film removal exposing the surface of the metal panel is the criterion for failure.

5. Significance and Use

5.1 Effective solid film lubricant coatings must adhere to surfaces to provide adequate lubrication in applications with restricted access where fluid lubricants cannot easily be replenished. Loss of coating adhesion results in metal to metal contact causing significant wear of contacting surfaces. Adhesion is critical to the performance of the solid film lubricant. Examples of solid film lubricant applications include fasteners, bearings and sliding members in automotive, aircraft, and aerospace hardware.

5.2 This test method is intended to determine the adhesion of solid film lubricant coatings when submitted to contact with water and other fluids. Results of this test provide an indication of the suitability of the lubricant coating in applications where contact with water or other fluids is likely.

6. Apparatus

6.1 *Rubber Covered Steel Roller*—A steel roller, 82.6 ± 2.5 mm (3.25 ± 0.1 in.) in diameter and 44.5 ± 1.3 mm (1.75 ± 0.05 in.) in width, covered with rubber approximately 6.4 mm (¼ in.) in thickness having a durometer hardness of 80 ± 5. The weight of the roller proper which applies pressure to the specimen shall be 2.04 ± 0.05 kg (4.5 ± 0.1 lb). It shall be so constructed that the weight of the handle is not added to the weight of the roller during use.

6.2 *Stylus,* or equivalent.[5]

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.L0.05 on Solid Lubricants.

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[2] Refer to U. S. Military Specification MIL-L-46010–March 4, 1988.

[3] 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.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[5] L. S. Starrett Scratch Gage No. 29 or equivalent.

6.3 *Oven,* forced-circulation, capable of maintaining 149 ± 5.5°C (300 ± 10°F).

6.4 *Micrometer,* reading 0 to 25 ± 0.0025 mm (0 to 1 ± 0.0001 in.) with a 1-ball anvil.

7. Reagents and Materials

7.1 *Test Panels,* of aluminum alloy 2024 (conforming to Specification B209M, approximately 75 by 150 by 0.5 mm (3 by 6 by 0.020 in.) thick, anodized in accordance with Practices D1730, Type C, Method 2, chromic acid coatings.

7.2 *Tape, Masking,* 25 mm (1 in.) wide, made of paper (pressure-sensitive) with an adhesive strength of at least 28 kg/m (25 oz/in.) when tested in accordance with Procedure A of Test Methods D3330/D3330M.

NOTE 1—A suitable tape meeting this specification is available commercially.[6] It must be less than 12 months old. Its adhesion strength may be checked by using Test Methods D1000 to ensure uniformity.

7.3 *Water,* conforming to Specification D1193.

7.4 *Solvent,* safe, non-filming, nonchlorinated.

NOTE 2—Petroleum distillates and hexanes formerly used as solvents in this test method, have been eliminated due to possible toxic effects. Each user should select a solvent that can meet the applicable safety standards and still thoroughly clean the parts.

8. Test Sample and Specimen Preparation

8.1 Have a sufficient quantity of solid film lubricant to perform the test. Prepare the test panels as follows:

8.1.1 Liquid-degrease in a solvent conforming to the requirements of 7.4. The panels shall be considered clean when the surface maintains a continuous water film for a period of at least 1 min after immersion in clean water at a temperature of 38 ± 3°C (100 ± 5°F) in accordance with 1.1 of Test Method F22.

8.1.2 Coat the test panels with dry solid film lubricant by means of spraying or an equivalent method to produce a dry film thickness between 0.005 and 0.013 mm (0.0002 and 0.0005 in.) and cure the film.

8.1.3 In most cases, curing shall be carried out according to the particular manufacturer's specifications. If such instructions are not provided, cure the film by air drying for 6 h at 26.7 ± 3°C (80 ± 5°F) or by air drying for 30 min at 26.7°C (80°F) followed by 1 h in an air-circulating oven at 149°C (300°F).

8.1.4 Measure the dry film thickness using a micrometer or equivalent gage.

9. Procedure A—For Resin-Bonded Coatings

9.1 Immerse the panels in a beaker of water to a depth of half the length of the panel for 24 h at room temperature. Take care to ensure that the panels are separated.

[6] Masking tape No. 250, available from the Minnesota Mining and Manufacturing Co. has been found satisfactory for this purpose.

9.2 Remove panels and wipe dry with a soft, dry, lint-free cloth. Air dry the panels at 25 ± 3°C (77 ± 5°F) at a relative humidity between 45 and 55 % for 1 ± 0.1 h.

9.3 Using the stylus, make two parallel scratches 25 mm (1 in.) apart on the panels (within 1 min after drying). Scratches shall be through the films (break through), parallel to long dimension of panel, and pass through both the water-immersed section and dry section.

9.4 Place a piece of masking tape lightly over the panel, perpendicular to the scratches, and press the tape down with two passes of the roller. The panel shall be resting on a hard surface and minimum pressure shall be exerted by the operator on the roller during the rolling operation. The tape shall be placed over both the immersed and dry sections.

9.5 Remove the tape with an abrupt motion.

9.6 Examine the test panel visually.

9.7 Report loss of adhesion of the film from the surface of the panel. Film removal exposing areas of the metal surface is indicative of poor adhesion characteristics.

9.8 Report the conditions of application and of curing the coating.

10. Procedure B—For Silicate or Phosphoric Acid-Bonded Coatings

10.1 Proceed in accordance with 9.3-9.8, omitting 9.1 and 9.2.

11. Procedure C—For All Coatings, Resistance to Fluids Other Than Water

11.1 Place 300 ± 10 mL of each test fluid under consideration in a separate 600-mL Griffin beaker, and suspend a coated panel in each in such a manner that approximately one half of each panel is immersed. Permit the panels to remain in the test fluid at 74 ± 2°F (23 ± 1°C) for 24 ± 0.25 h.

11.2 Remove the panels from the test fluid and allow them to drain for 1 ± 0.1 h. Dip each panel in three separate rinses of a solvent, conforming to the requirements of 7.4, and permit them to air dry for at least 1 h.

11.3 Proceed in accordance with 9.3-9.8.

NOTE 3—Procedure C is based on military requirements for resistance to fuels, solvents, lubricants, and hydraulic fluids which are readily removed by the solvent indicated in 7.4. If it is desired to apply it to chemical rocket propellants or other fluids immiscible with this solvent, or which are volatile enough to need no solvent, appropriate variations are required. These shall become part of the test report, as shall the identification of the fluids used.

12. Precision and Bias

12.1 Since the results of the test are only intended to give a pass/fail rating, no statement will be made about either the precision or the bias of this test method.

13. Keywords

13.1 adhesion; fluid resistance; solid film lubricant