Designation: D 3214 – 96

AMERICAN SOCIETY FOR TESTING AND MATERIALS
100 Barr Harbor Dr., West Conshohocken, PA 19428
Reprinted from the Annual Book of ASTM Standards. Copyright ASTM

Standard Test Methods for Coating Powders and Their Coatings Used for Electrical Insulation[1]

This standard is issued under the fixed designation D 3214; 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 These test methods cover the evaluation of the properties of organic resinous powders and their fused coatings used for electrical insulation.

NOTE 1—These test methods do not apply to ceramic, glass, or metal powder.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are 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.* For specific hazard statements, see Section 5.

2. Referenced Documents

2.1 *ASTM Standards:*

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies[2]

D 150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[2]

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials[2]

D 522 Test Methods for Mandrel Bend Test of Attached Organic Coatings[3]

D 523 Test Method for Specular Gloss[3]

D 609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products[3]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[4]

D 621 Test Methods for Deformation of Plastics Under Load[4]

D 792 Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement[4]

D 1040 Specification for Uninhibited Mineral Oil for Use in Transformers and in Oil Circuit Breakers[5]

D 1895 Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials[6]

D 1898 Practice for Sampling of Plastics[6]

D 1921 Test Methods for Particle Size (Sieve Analysis) of Plastic Materials[6]

D 2240 Test Method for Rubber Property—Durometer Hardness[7]

D 2304 Test Method for Thermal Evaluation of Rigid Electrical Insulating Materials[2]

D 2967 Test Method for Edge Coverage of Coating Powders[8]

D 4217 Test Method for Gel Time of Thermosetting Coating Powder[8]

D 4242 Test Method for Glass Plate Flow for Thermosetting Coating Powders[8]

2.2 *National Fire Protection Association Bulletins:*

No. 33 Spray Finishing[9]

No. 654 Dust Explosion Prevention Plastics Industry[9]

3. Terminology

3.1 *Definitions:*

3.1.1 *coating powder, n*—a heat-fusible, finely divided, solid, resinous material to form electrical insulating coatings.

3.1.1.1 *Discussion*—The coating powder may contain fillers, colorants, curing agents, etc., consistent with producing the desired coatings. The powder is applied by various methods such as spraying, sprinkling, or dipping. Usually hot parts are used. Heat causes the powder to melt and flow into a dense coating.

3.1.2 *powder coating, n*—a coating produced by the use of a heat-fusible coating powder.

3.1.2.1 *Discussion*—Some powder coatings thermoset after fusion at the recommended temperature and there should be little loss of volatile material. In general, the coating should be

[1] These test methods are under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and are the direct responsibility of Subcommittee D01.51 on Powder Coatings.

Current edition approved March 10, 1996. Published May 1996. Originally published as D 3214 – 73. Last previous edition D 3214 – 91 (1995).

[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 06.01.

[4] *Annual Book of ASTM Standards*, Vol 08.01.

[5] Discontinued, see *1979 Annual Book of ASTM Standards*, Part 40.

[6] *Annual Book of ASTM Standards*, Vol 08.02.

[7] *Annual Book of ASTM Standards*, Vol 09.01.

[8] *Annual Book of ASTM Standards*, Vol 10.02.

[9] Available from the National Fire Protection Assn., International, 60 Batterymarch St., Boston, MA 02110.

smooth, continuous, electrically insulating, and adherent to the metal, showing no evidence of unfused particles, holes, or pores.

4. Summary of Test Methods

4.1 These test methods describe the specific procedures for specimen preparation and testing of powders and their coatings used for electrical insulation. The powders are applied to metal surfaces and fused with heat to form a coating. Wherever possible, ASTM methods are referenced with notes on special treatment that may be required.

5. Hazards

5.1 **Warning**—The powders may be subject to dust explosions under certain conditions (see National Fire Protection Association Bulletins No. 33 and No. 654).

5.2 **Warning**—Provide adequate ventilation, and avoid breathing the dust or fumes and contact with skin since many of the reactive materials used in coating powders have been reported to be toxic or cause irritation to sensitive skin.

6. Sampling

6.1 Use Method A of Practice D 1898 for sampling the powder.

6.2 Use specimens required for specific tests of the coating.

7. Test Panels

7.1 Steel test panels, where required, shall be in accordance with Practice D 609.

7.1.1 The panels shall have the following dimensions: 0.81 mm (0.032 in.) thick, 89 mm (3½ in.) wide, and 152 mm (6 in.) long, with a No. 5 temper, No. 5 edge, and No. 2 finish.

7.1.2 Clean the test panels using Method A of Practice D 609.

7.1.3 Apply the coating powder to the panel by any specified method such as dip, spray, electrostatics, or other to obtain a fused thickness on test panels of 0.254 ± 0.025 mm (10 ± 1 mil) unless otherwise specified. Include the method of application in the report.

7.2 Prepare coatings to be tested as free films by coating polytetrafluoroethylene panels or steel panels treated with a release agent to facilitate the removal of the film after curing.

7.3 Other test panels shall be as specified in the test method.

8. Conditioning

8.1 Condition test specimen as provided in Practice D 618, Method A, unless otherwise specified.

9. Test Methods

9.1 Test coating powders as received in accordance with the following:

9.1.1 *Apparent Density*—Test Methods D 1895, Method A.

9.1.2 *Bulk Factor*—Test Methods D 1895.

9.1.3 *Pourability*—Test Methods D 1895.

9.1.4 *Particle Size and Distribution Sizes*—Test Methods D 1921, Method A.

9.1.5 *Weight Loss on Curing*:

9.1.5.1 Weigh a powder specimen of 1 ± 0.1 g to the nearest 0.001 g in an aluminum weighing dish approximately 50 mm in diameter. Heat the evenly spread powder at the time and temperature recommended to fuse and cure the coating. Cool the specimen to 23 ± 1°C and reweigh to the nearest 0.001 g.

9.1.5.2 Calculate the percent weight loss on the basis of the original powder weight.

9.2 *Cured Coatings*:

9.2.1 *Specific Gravity*:

9.2.1.1 *Test Specimens*—Approximately 6.45 cm^2 (1 $in.^2$) of free film prepared in accordance with 7.2. Remove all mold release by washing in a solvent that does not affect the material.

9.2.1.2 *Procedure*—Test in accordance with Test Methods D 792, Method A.

9.2.2 *Electric Strength*:

9.2.2.1 *Test Specimens*—Use a steel panel in accordance with 7.1, unless otherwise specified.

9.2.2.2 *Procedure*—Test in accordance with Test Method D 149, using the short-time procedure at a rate of rise of 0.5 kV/s in uninhibited oil in accordance with Specification D 1040 with brass electrodes of 6.4 mm (¼ in.) in diameter, and 0.8 mm (1⁄32 in.) radius edges. Measure the coating thickness at the test area.

NOTE 2—Grind the test panel.

9.2.3 *Dissipation Factor and Permittivity*:

9.2.3.1 *Test Specimens*—The test specimen shall be a 152-mm (6-in.) long by 25.4-mm (1-in.) in diameter steel bar, coated with the powder to the specified thickness. One end of the bar must be uninsulated for electrical contact. Measure the bar at the same location before and after coating to determine thickness.

9.2.3.2 *Electrodes*—Paint on the measuring electrode 102 mm (4 in.) long using a silver paint in accordance with Test Methods D 150. The electrode must be wide enough to achieve adequate capacitance for the measurement. Paint the guard electrodes on each side of the measuring electrode in accordance with the procedure described in Test Methods D 150.

9.2.3.3 *Procedure*—Test in accordance with Test Methods D 150, using 100 V or less and a frequency of 60 to 100 Hz at Standard Laboratory Atmosphere conditions.

9.2.4 *Insulation Resistance*:

9.2.4.1 *Test Specimens*—Prepare the test specimen in accordance with 9.2.3.1.

9.2.4.2 *Procedure*—Test in accordance with Test Methods D 257, use Fig. 6 of Test Methods D 257 for electrodes and use a test voltage of 500 V after 1 min. Condition for 96 h at 35°C and 90 % relative humidity. Test at 35°C and 90 % relative humidity.

9.2.5 *Cold Flow*:

9.2.5.1 *Test Specimens*—Mold the test specimens, or cut them from free films made in accordance with 7.2.

9.2.5.2 *Procedure*—Test in accordance with Test Methods D 621, Method A.

9.2.6 *Elongation*:

9.2.6.1 *Test Specimens*—The test specimen shall be a steel panel in accordance with 7.1, except cut it to a 114.3-mm (4½-in.) length.

9.2.6.2 *Procedure*—Test in accordance with Test Method D 522.

9.2.7 *Gloss*:

9.2.7.1 *Test Specimens*—Use a steel panel in accordance with 7.1.

9.2.7.2 *Procedure*—Test in accordance with Test Method D 523.

9.2.8 *Thermal Endurance*:

9.2.8.1 *Test Specimens*—Use a steel panel in accordance with 7.1.

9.2.8.2 *Procedure*—Test in accordance with Test Method D 2304, using electric strength as a measurement of the degradation of the film.

9.2.9 *Edge Coverage*—Test in accordance with Test Method D 2967, using the test bars specified.

9.2.10 *Hardness*:

9.2.10.1 *Test Specimens*—Use a steel panel in accordance with 7.1.

9.2.10.2 *Procedure*—Test in accordance with Test Method D 2240, using a Type D durometer.

9.2.11 *Gel Time*:

9.2.11.1 *Test Specimen*—Use powder as specified in Test Method D 4217.

9.2.11.2 *Procedure*—Test in accordance with Test Method D 4217 using powder as specified.

9.2.12 *Glass Plate Flow*:

9.2.12.1 *Test Specimen*—Use powder as specified in Test Method D 4242.

9.2.12.2 *Procedure*—Test in accordance with Test Method D 4242 using powder as specified.

10. Report

10.1 Report the following information:

10.1.1 Complete identification of material tested,

10.1.2 Description of specimens, including number, preparation method, and thickness of coating,

10.1.3 Temperature of test, if other than 23°C,

10.1.4 Type and manufacture of test equipment,

10.1.5 All specific information called for in the individual test method reports,

10.1.6 Test results, as calculated or observed values and basis of data, median or mean value, and

10.1.7 Date of test.

11. Precision and Bias

11.1 Precision and bias have not been assessed for all tests referenced in these test methods. When these statements are provided, they are included in ASTM test methods referenced in Section 9.

12. Keywords

12.1 bulk factor; coating powder; cold flow; dielectric strength; dissipation factor; edge coverage; elongation; gel time; glass plate flow; hardness; insulation resistance; particle distribution; particle size; pourability; powder coating; thermal endurance; weight loss on curing