Designation: D 5235 – 97

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 Method for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products[1]

This standard is issued under the fixed designation D 5235; 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 test method covers the measurement of dry film thickness of coatings applied to a smooth, textured or curved rigid substrate of wood or a wood-based product.

1.2 This test method covers the preparation of wood or wood-based specimens for the purpose of microscopical measurement of dry film thickness.

1.3 This test method suggests an interpretation of dry film thickness of coatings on wood or wood-based products when porous substrates are coated.

1.4 This test method suggests an interpretation of dry film thickness of coatings on wood or wood-based products when substrate attached or non-attached fibers occur in the dry film.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.6 *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 hazard statements are given in Section 7.

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *dry film thickness*—that layer of thickness of dried coating above the microscopically visible board surface that also comprises attached fibers but excludes free fibers that are encapsulated in the layer itself.

2.1.2 *edge face*—That part of the specimen that is a plane perpendicular to the surface showing a cross section of the coating and substrate.

2.1.3 *soak in*—refers to a coating on a porous substrate where the coating does not lie essentially on the surface of the wood or wood-based product, but has penetrated into the fiber structure of the wood or wood-based material.

2.1.3.1 *Discussion*—Wood or wood-based products are generally of a porous nature; sometimes exhibiting uniform absorption of coatings. Frequently absorption of coatings is of a nonuniform nature and influenced by localized surface density differences or wood pore size. These conditions of coating absorption are commonly referred to as soak in.

3. Summary of Test Method

3.1 A specimen of coated wood or wood-based product is cut to convenient size and edge polished with sandpaper.

3.2 The polished edge of the specimen is viewed through a calibrated microscope in order to measure dry film thickness.

3.3 Suggestions regarding interpretation of dry film thickness on porous wood or wood-based material are offered.

3.4 Suggestions regarding interpretation of dry film thickness on wood or wood-based material that have attached or encapsulated fibers in the coating are offered.

4. Significance and Use

4.1 The dry film thickness of coatings on wood or wood-based products is specified in written product warranties for proper decorative and protective performance of coatings on wood or wood-based products.

4.2 The minimum and maximum dry film thickness of coatings is recommended by coating companies for satisfactory decorative and protective performance on wood or wood-based products.

4.3 The average dry film thickness of coatings on wood or wood-based material may be used by manufacturing companies to calculate theoretical cost of applied coatings. By comparison with actual cost, utilization efficiency may be calculated.

4.4 The ratio of peak to valley dry film thickness on textured products is used as an indication of coating uniformity.

4.5 Specific coated product requirements may dictate certain film thickness determinations to be made. Discussions between buyer and seller may be advisable to accommodate product needs relative to dry film thickness.

5. Apparatus

5.1 *Calibrated*[2] *Monocular Microscope*, equipped with an optical system[3] providing sufficient resolution of 0.1-mil (2.54-μm) dry film thickness. One system consisting of a 16-mm

[1] This test method is under the jurisdiction of ASTM Committee D-1 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.52 on Factory-Coated Wood Products.

Current edition approved Feb. 10, 1997. Published September 1997. Originally published as D 5235 – 92. Last previous edition D 5235 – 92.

[2] Consult the microscope manufacturer's operational manual for the correct calibration procedure.

[3] Video microscope instruments are available that are also capable of the required resolution and measurement accuracy.

objective and a 10-power filar micrometer eyepiece, resulting in a magnification of at least 100 diameters, has been found satisfactory. Other combinations of objectives and eyepieces and other magnifications may also be suitable, although magnifications above 200 diameters may result in distortion of the viewed cross section.

5.2 *Source of Oblique Illumination,* for the microscope.

5.3 *Cutoff Saw*.

5.4 *Belt or Disc Sander*.

5.5 *C-Type Clamp*.

6. Materials

6.1 *200 and 600-Grit Sand Paper*.

6.2 *Mold,* such as a paper cup, aluminum weighing dish, or a 2-in. (50.8-mm) or larger diameter plastic pipe that is at least 1-in. (25.4-mm) high.

6.3 *Source of Sanding Adhesive*, which is used as encapsulating medium such as:

6.3.1 *Hot Melt Glue*,

6.3.2 *Fast-Cure Acrylic Mounting Kit*,[4] and

6.3.3 *Epoxy*.

6.4 *Solvent-borne Tint Dispersion,* which is compatible with the sanding adhesive.

6.5 *Mineral Oil*.

6.6 *Automotive Red Transmission Oil*.

6.7 *Zinc Stearate Powder*.

7. Hazards

7.1 Use saws and sanders with goggles, dust mask, and proper machine safeguards to prevent injury to body limbs.

7.2 Solvent-based tint dispersions and adhesives may be flammable and contain toxic solvents. See manufacturer's instructions for use and proper disposal.

8. Procedure

8.1 *Specimen Preparation*:

8.1.1 Select the desired coated area of a wood or wood-based material that is to be measured for dry film thickness. With the cutoff saw, cut off a sample at least 1½-in. (38.1 mm) wide from this area.

8.1.2 Cut this specimen to a length that is at least ½-in. (12.7 mm) less than the inside diameter of the mold to be used.

8.1.3 Place the specimen, with the sample edge to be measured, face down and approximately centered in the mold.

8.1.4 Prepare the sanding adhesive according to the manufacturer's direction for use. A dispersed pigment[5] may be added to the adhesive for better microscopic contrast between the dry film and the adhesive.

8.1.5 Pour the sanding adhesive around the sample in the mold and allow to harden according to the manufacturer's directions.

8.1.6 Remove the mold from the hardened and encapsulated specimen edge.

8.1.7 Using a disc sander, belt sander or 200-grit sandpaper mounted on a glass plate, sand the edge face of the encapsulated specimen to be measured until the edge face is relatively smooth. Maintain the edge face of the specimen as flat as possible during sanding. Avoid heat buildup of the sanding adhesive by intermittent sanding if necessary.

8.1.8 Polish the edge face of the rough sanded specimen as follows:

8.1.8.1 Mount a piece of 600-grit sandpaper on a flat glass plate. Rub the edge face of the rough sanded specimen over the 600-grit sandpaper in one direction, then reverse direction by 180° for several more rubs. Zinc stearate powder can be sprinkled on the 600-grit sandpaper or the 600-grit sandpaper can be wetted with mineral oil to produce a highly polished edge face free of scratches.

8.1.9 To improve the microscopic contrast between the coating and the wood or wood-based product, wipe a light film of mineral oil or automotive red transmission oil across the polished edge face with a clean cotton rag or equivalent.

8.1.10 Some coatings and substrates are hard enough that encapsulation with a sanding adhesive is not necessary. Although in all cases, use of the encapsulating sanding adhesive will lead to the sharpest microscopic edge face and the highest degree of accuracy.

8.1.11 Some laboratories find that a mold for the specimen encapsulation with sanding adhesive is not necessary. In this case two specimens are prepared with the cut off saw. The sanding adhesive after proper mixing is generously applied to the coated face of each specimen, the specimens are placed together and a C-clamp is used to squeeze out some of the sanding adhesive. The C-clamp is not removed until the sanding adhesive has hardened.

8.2 *Measurement for the Microscopic Dry Film Thickness of the Polished Edge Face of the Specimen*:

8.2.1 Place the polished edge face under the microscope lens.

8.2.2 Adjust the illuminating light at a convenient oblique angle.

8.2.3 Focus the 10-power filar micrometer eyepiece on one side of the dry film thickness spot to be measured.

8.2.4 Advance the 10-power filar micrometer so as to reach the other side of the spot to be measured in 8.2.3.

8.2.5 Read the micrometer and calculate the dry film thickness by multiplying the distance in millimetres or inches per drum division on the micrometer by the number of drum divisions in the reading by the calibration factor.

8.2.6 Multiply the calculated number in 8.2.5 by 1000 for English units (39.37 for metric units), for conversion to a dry film thickness in mils.

8.2.7 Porous substrates tend to have the coating soaked into the open fiber structure of the wood or wood-based product. A clear demarcation line between substrate and coating is not discernible. In this case, it is suggested that film thickness is that layer of dry film thickness above the microscopically visible board surface that also comprises attached fibers but excludes free fibers that are encapsulated in the layer itself (see Fig. 1, Fig. 2 and Fig. 3).

8.2.8 Several microscope companies have advanced optical

[4] The sole source of supply of this item known to the committee at this time is Buehler Ltd., 41 Waukegan Rd., P. O. Box 1, Lake Bluff, IL 60044. If you are aware of alternative suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.

FIG. 1 Illustrates Film Thickness Above the Wood Surface Where the Coating Layer Encapsulates Free Wood Fibers

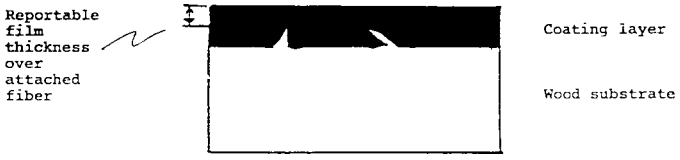

FIG. 2 Illustrates Film Thickness with Wood Fibers Attached to the Wood Surface and Surrounded by a Coating Layer

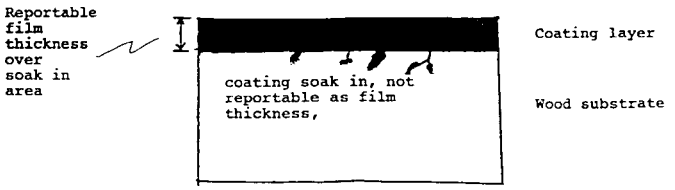

FIG. 3 Illustrates Coating Soak In, Not Reportable as Film Thickness

systems and useful accessories for measuring dry film thickness of coatings on properly prepared coated wood or wood-based specimens. The use of their equipment for the measurement of dry film thickness on wood or wood-based products is highly recommended. The directions for use of the equipment are specific to each microscope company. Closely follow the manufacturer's instructions.

9. Report

9.1 Report the dry film thickness of the spot to be measured in mils or microns.

9.2 For textured substrates, report the following information (see Fig. 4):

9.2.1 The dry film thickness in the valleys,

9.2.2 The dry film thickness on the shoulders or slopes,

9.2.3 The dry film thickness on the peaks,

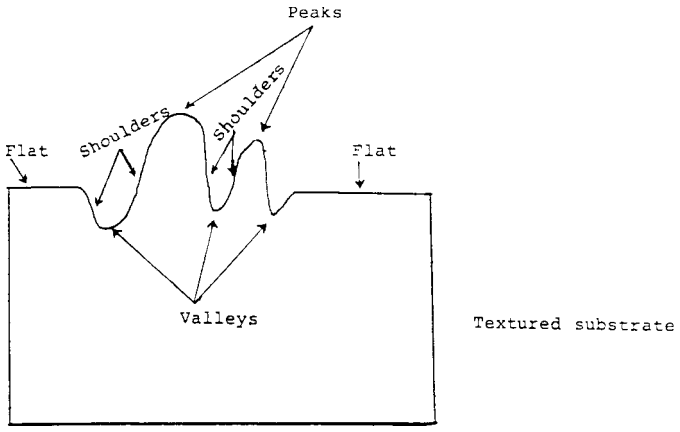

FIG. 4 Illustrates the Peaks, Shoulders (Slopes), Valleys and Flat Areas of a Textured Substrate

9.2.4 The dry film thickness on the flat areas if any, and

9.2.5 Optionally some laboratories report the ratio of the peak to valley dry film thickness or the average of multiple dry film readings of one or all of these substrate areas.

9.3 For woods with large pores ignore the soak in of coating into the wood pore or cell and report only the dry film thickness above the microscopically visible board surface (see Fig. 5).

10. Precision and Bias

10.1 The precision and bias for this test method are primarily dependent upon each operator choosing exactly the same spot on the polished specimen for measurement.

10.2 The precision and bias statements will be developed in round-robin testing.

11. Keywords

11.1 coated wood or wood-based product; dry film thickness; microscopic measurement

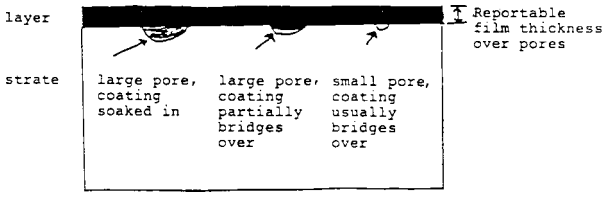

FIG. 5 Illustrates Film Thickness On Wood Substrates With Large Pores