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Standard Guide for Determination of Thickness of Plastic Film Test Specimens[1]

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1. Scope

1.1 This guide covers the determination of the thickness of plastic films where the thickness is used directly in determining the results of tests for various properties. Use this practice except as otherwise required in material specifications or in applicable test standards.

NOTE 1—Film is defined in Terminology D883 as an optional term for sheeting having a nominal thickness no greater than 0.25 mm (0.010 in.).

NOTE 2—Alternative methods are acceptable if they meet the requirements of measurement precision as noted in this guide.

NOTE 3—This guide is not intended to address the sampling techniques or the measurement of film thickness for the commercial classification of commercial products or for quality control purposes.

1.2 The values stated in SI units are to be regarded as the standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 4—This standard and ISO 4593 address the same subject matter but differ in technical content.

1.4 *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]

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D5947 Test Methods for Physical Dimensions of Solid Plastics Specimens

D6287 Practice for Cutting Film and Sheeting Test Specimens

2.2 *ISO Standard:*

ISO 472 Plastics—Vocabulary[3]

3. Terminology

3.1 *Definitions*—See Terminologies D883 and ISO 472 for definitions pertinent to this guide.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *absolute uncertainty (of a measurement), n*—the smallest division that can be read directly on the instrument used for measurement.

3.2.2 *calibration, n*—the set of operations that establishes, under specified conditions, the relationship between values measured or indicated by an instrument or system, and the corresponding reference standard or known values derived from the appropriate reference standards.

3.2.3 *dead-weight micrometer, n*—an instrument capable of measuring the thickness of thin films utilizing a weight to apply uniform pressure to the specimen.

3.2.4 *verification, n*—proof, with the use of calibrated standards or standard reference materials that the calibrated instrument is operating within specified requirements.

4. Summary of Methods

4.1 This guide describes four different methods for the thickness measurement of plastic film specimens. The methods (identified as Methods A, B, C, and D) use different micrometers that actuate the weights in different manners or utilize different means of reading the thickness.

4.2 It is permissible to use other instruments, including non-contact instruments and instruments using alternative readout systems in place of dials provided they meet or exceed the precision requirements noted in this practice.

5. Significance and Use

5.1 This guide is intended to provide recommendations and suggested good practices to determine precise dimensions when necessary for the calculation of properties expressed in

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

physical units. It is not intended to replace practical thickness measurements based on commercial portable tools, nor is it implied that thickness measurements made by the procedures will agree exactly.

6. Apparatus

6.1 The instruments described in this guide share many common features:

6.1.1 A dead-weight gauge calibrated in accordance with the guidelines described in Appendix X2 and consisting of the following:

NOTE 5—Additional guidance for calibration and verification of gauges can be found in Test Method D5947.

NOTE 6—Since there is such a wide variety of instruments in use, there can be significant differences in the accuracy of different instrument types. The values stated for each type of apparatus are intended to be typical of that type of instrument.

6.1.1.1 A presser foot that moves in an axis perpendicular to the anvil face;

6.1.1.2 The surfaces of the presser foot and anvil (which contact the specimen) parallel to within 2.5 µm;

6.1.1.3 A spindle, vertically oriented if a dead-weight apparatus;

6.1.1.4 An indicator essentially capable of repeatable readings within ± 0.001 mm at zero setting or within ±0.001 mm when using a steel gauge block;

6.1.1.5 A frame, housing the indicator, of such rigidity that a load of 15 N applied to the housing, out of contact with the presser foot spindle (or any weight attached thereto), will produce a deflection of the frame not greater than the smallest scale division or digital count on the indicator;

6.1.1.6 If employed, a dial diameter of at least 50 mm and graduated continuously to read directly to the nearest 2.5 µm. The dial can be equipped with a revolution counter that displays the number of complete revolutions of the large hand, or

6.1.1.7 An electronic instrument having a digital readout in place of the dial indicator if that instrument meets all of the other requirements of this guide, and

6.1.1.8 The force applied to the presser foot spindle and the force necessary to register a change in the indicator reading shall be less than the force that will cause deformation of the specimen. The force applied to the presser foot spindle and the force necessary to just prevent a change in the indicator reading shall be more than the minimum permissible force specified for a specimen.

6.2 *Apparatus A—Manually Operated Thickness Gauge:*

6.2.1 An instrument having a presser foot and spindle that is manually lifted and lowered.

6.3 *Apparatus B—Automatically Operated Thickness Gauge:*

6.3.1 A pneumatic or motor-operated instrument having a presser foot spindle that is lifted and lowered either by a pneumatic cylinder or by a constant-speed motor through a mechanical linkage such that the rate of descent (for a specified range of distances between the presser foot surface and anvil) and dwell time on the specimen are within the limits specified for the material being measured.

6.3.2 A preferred drop rate between 0.750 and 1.500 mm/s between 0.625 and 0.025 mm on the dial and a capacity of at least 0.775 mm.

6.4 *Apparatus C—Manually Operated Thickness Gauge with Linear Optical Encoder:*

6.4.1 Similar to Apparatus A except it employs a digital device with an electronic readout capable of repeatable readings to within ± 1 µm at zero setting or on a steel gauge block and a linear optical encoder using a scale of increments not less than 100 lines/mm and capable of reading within 0.5 µm with a 10 mm range.

6.5 *Apparatus D—Automatically Operated Thickness Gauge with Digital Display:*

6.5.1 Similar to Apparatus B except it employs an electronic device with a digital readout capable of a resolution not less than 0.5 µm and repeatable readings to within ± 1 µm at zero setting or on a steel gauge block.

6.5.2 A preferred drop rate between 0.750 and 1.500 mm/s between 0.625 and 0.025 mm on the dial and a capacity of at least 0.775 mm.

6.6 *Other Instruments:*

6.6.1 Other instruments are commercially available that utilize different methods of measuring thickness. These are generally non-contact devices employing ultrasonic response, electrical capacitance, or similar material properties that can be correlated to thickness. Some of these devices are also designed to provide a means of measuring discreet sections of film in a continuous scanning mode. Instruments of this nature are acceptable provided they meet or exceed the precision requirements noted in this practice and the requirements of the applicable material or product specifications or applicable test standards.

7. Test Specimens

7.1 The test specimens shall be prepared from plastic films that have been cut to the required dimensions according to Practice D6287.

7.2 Allow specimens to equilibrate at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 10 % relative humidity in accordance with Procedure A of Practice D618 unless otherwise specified by agreement or the relevant ASTM material specification.

7.3 Unless otherwise specified, make all dimension measurements at the same conditions used for equilibration.

7.4 For each specimen, take precautions to prevent damage or contamination that will adversely affect the measurements.

8. Procedure

8.1 *General Guidelines:*

NOTE 7—In this section, the word "method" denotes a combination of both a specific apparatus and a procedure describing its use.

8.1.1 The selection of a method for measurement of film thickness is influenced by the characteristics of the film for measurement. Each material and, in some cases, film construction in the case of multi-layer structures, will differ in its response to test method parameters, which include, but are not limited to, compressibility, rate of loading, ultimate load, dwell