~~Designation:D7378–07~~ Designation: D7378 – 10

Standard Practice for Measurement of Thickness of Applied Coating Powders to Predict Cured Thickness[1]

This standard is issued under the fixed designation D7378; 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 the thickness measurement of dry coating powders applied to a variety of rigid substrates. Use of some of these procedures may require repair of the coating powder. This practice is intended to supplement the manufacturers' instructions for the operation of the gages and is not intended to replace them. It includes definitions of key terms, reference documents, the significance and use of the practice, and the advantages and limitations of the instruments.

1.2 Three procedures are provided for measuring dry coating powder thickness:

1.2.1 *Procedure A*—Using rigid metal notched (comb) gages.

1.2.2 *Procedure B*—Using magnetic or eddy current ~~coating~~dry film thickness gages.

1.2.3 *Procedure C*—Using non-contact ultrasonic powder thickness instruments.

1.3 Coating powders generally diminish in thickness during the curing process. ~~These~~Some of these procedures therefore require a reduction factor be established to predict cured film thickness of powder coatings.

1.4 *Procedure A and Procedure B* measure the thickness (height or depth) of the applied coating powders in the pre-cured, pre-gelled state. By comparing results to the measured cured powder thickness in the same location, a reduction factor can be determined and applied to future thickness measurements of the same coating powder.

1.5 *Procedure C* results in a predicted thickness value of the cured state based on a calibration for typical coating powders. If the powder in question is not typical then ~~a calibration~~an adjustment can be made to align gage readings with the actual cured values as determined by other measurement methods.

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

1.7 *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:*[2]

D4138 Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means

D6132 Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accuracy*, *n*—the measure of the magnitude of error between the result of a measurement and the true thickness of the item being measured.

3.1.2 *adjustment*, *n*—the physical act of aligning a gage's thickness readings to match those of a known thickness sample ~~(removal~~(reduction of bias) in order to improve the accuracy of the gage on a specific surface, within a specific portion of its measurement range or to specific operating conditions.

[1] This practice is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.51 on Powder Coatings.

~~Current edition approved July 1, 2007. Published July 2007. DOI: 10.1520/D7378-07.~~

Current edition approved Dec. 1, 2010. Published January 2011. Originally approved in 2007. Last previous edition approved in 2007 as D7378 - 07. DOI: 10.1520/D7378-10.

[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.

3.1.2.1 *Discussion*—An adjustment will affect the outcome of subsequent readings.

3.1.3 *coating powders*, *n*—finely divided particles of resin, either thermoplastic or thermosetting, generally incorporating pigments, fillers, and additives and remaining finely divided during storage under suitable conditions, which, after fusing and possibly curing, give a continuous film.

3.1.4 *calibration*, *n*—the high-level, controlled and documented process of obtaining measurements on traceable calibration standards over the full operating range of the gage, then making the necessary gage adjustments (as required) to correct any out-of-tolerance conditions.

3.1.4.1 *Discussion*—Calibration of coating thickness gages is performed in a controlled environment using a documented process by the equipment manufacturer, an authorized agent, or by an authorized, trained calibration laboratory. The outcome of the calibration process is to restore/realign the gage to meet/exceed the manufacturer's stated accuracy and may result in the creation of a calibration certificate recording the results of the process at the time of testing.

3.1.5 *powder coatings*, *n*—coatings which are protective or decorative, or both, formed by the application of a coating powder to a substrate and fused in a continuous film by the application of heat or radiant energy.

3.1.6 *dry film thickness*, *n*—the thickness of a coating (or coating layers) as measured from the surface of the substrate.

3.1.7 *micrometer (micron)*, *n*—one one-thousandths of a millimeter (0.001 mm); 25.4 microns = 1 mil.

3.1.8 *mil*, *n*—an imperial unit of measure; one one-thousandths of an inch (0.001 in.); 1 mil = 25.4 microns.

3.1.9 *substrate*, *n*—the base material, type of surface or component that is being coated.

3.1.10 *uncured*, *adj*—~~the physical state of coating powder when electrostatically held, but not yet fused, to a substrate.~~ —the physical state of coating powder when particles are electrostatically held to a substrate.

3.1.11 *verification of accuracy*, *n*—~~obtaining measurements on a reference standard prior to gage use for the purpose of determining the ability of the coating thickness gage to produce reliable values, compared to the combined gage manufacturer's stated accuracy and the stated accuracy of the reference standard.~~ —comparing predicted thickness values with actual cured thickness values and ensuring both are within their combined tolerances.

4. Summary of Practice

4.1 The three procedures take measurements of applied coating powders in the pre-cured, pre-gelled state. Each procedure employs different devices to measure the dry powder.

4.2 *Procedure A*—Uses a metal notched gage to manually determine the thickness of the coating powder. The gage is dragged through the powder a short distance. Powder thickness is determined as being between the highest numbered tooth that made a mark and has powder clinging to it, and the next highest tooth that left no mark and has no powder clinging to it. Measurements can be made on a suitable rigid surface, metal or non-metal but marks will be made in the powder that may not be covered when the powder flows in the cure process.

4.3 *Procedure B*—Uses a conventional magnetic or eddy current coating thickness gage with a specially designed powder probe to measure the thickness of the coating powder. Micro pins, which are integrated into the probe, penetrate the coating powder down to the substrate. The probe is manually pressed down to the surface of the powder to effect a thickness measurement. This procedure is applicable to metal substrates only. Marks may be made in the powder that may not be covered when the powder flows in the cure process.

4.4 *Procedure C*—Uses a non-contact ultrasonic powder thickness instrument to take a measurement of the coating powder to calculate and display a predicted cured thickness. Measurements can be made on any rigid surface.

4.5 The thickness of dry coating powder diminishes during the curing process. To predict the cured powder coating thickness, a correlation must be made between pre-cured and post-cured thicknesses.

4.5.1 *Procedure A and Procedure B* result in a thickness measurement of the uncured coating powder only. A reduction factor must then be used to predict the cured powder thickness for each particular coating powder. This reduction factor is obtained by measuring the cured powder thickness at the same location where the uncured powder thickness measurement was taken. For best accuracy, measurements before and after curing should be taken for different thicknesses. A sample plot of measurement results is shown in Fig. 1. From this plot a reduction factor can be determined and applied to all future dry coating powder thickness measurements to predict cured thickness.

4.5.2 *Procedure C* does not provide a dry powder thickness measurement. The user can make ~~a calibration~~ an adjustment to the instrument by measuring the cured powder thickness at the same location where the uncured powder thickness measurement was taken and ~~aligning~~align the gage readings with the cured coating readings.

5. Significance and Use

5.1 Many physical and appearance properties of the finished coating are affected by the film thickness. Film thickness can affect the color, gloss, surface profile, adhesion, flexibility, impact resistance and hardness of the coating. The fit of pieces assembled after coating can be affected when film thickness is not within tolerance. Therefore coatings must be applied within certain minimum and maximum film thickness specifications to optimize their intended use.

5.2 All procedures involve taking measurements of applied coating powders in the pre-cured, pre-gelled state to help insure correct cured film thickness. This enables the application system to be set up and fine-tuned prior to the curing process. In turn, this will reduce the amount of scrap and over-spray. Accurate predictions help avoid stripping and re-coating which can cause

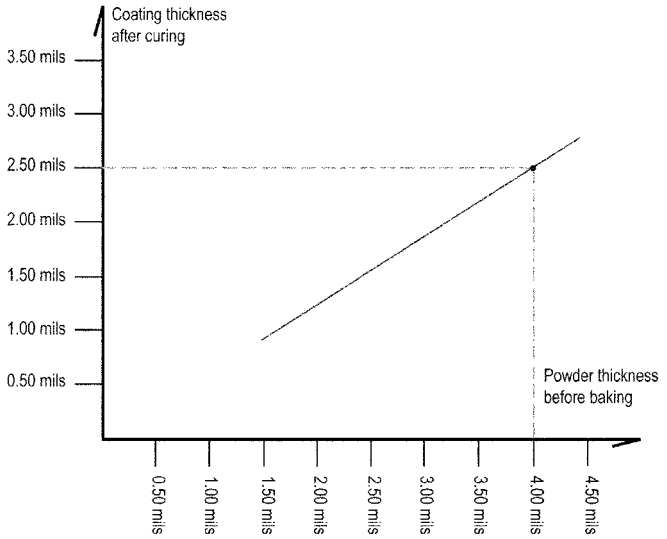

FIG. 1 Typical Correlation Between Pre- and Post-cured Powder

problems with adhesion and coating integrity.

5.3 Measurements of cured powder coating thickness can be made using different methods depending upon the substrate. Non-destructive measurements over metal substrates can be made with magnetic and eddy current coating thickness gages (see Practice D7091). Non-destructive measurements over non-metal substrates can be made with ultrasonic coating thickness gages (see Test Method D6132). Destructive measurements over rigid substrates can be made with cross-sectioning instruments (see ~~Test Method~~Practices D4138).

6. Test Specimen

6.1 The test specimen can be the coated part on which the powder thickness is to be evaluated, or can be test panels of similar material and shape on which it is desired to measure the coating thickness.

PROCEDURE A—METAL NOTCHED GAGES

7. Apparatus

7.1 *Metal Notched Gage* with at least one end (edge) consisting of a series of teeth extending from the body and spaced from each other. The teeth are of different length. Two legs or stand-offs extend beyond the teeth at both ends of the row of teeth to support the gage against the coated substrate (see Fig. 2). Several models are available to measure a broad range of coating powder thicknesses.

NOTE 1—Notched gages intended for measuring wet film thickness are generally not suitable for measuring powder thickness. They usually have square teeth with increments too fine for powder measurement.

8. Procedure

8.1 Select a test panel or choose a site for the thickness measurement.

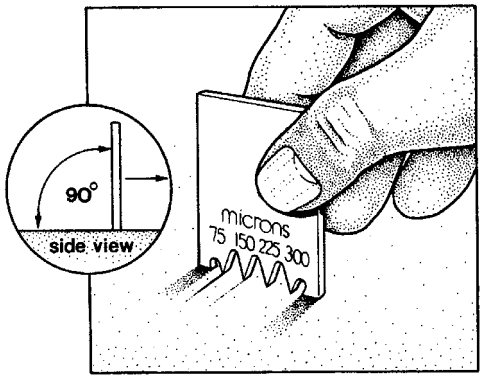

FIG. 2 A Metal Notched Gage