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GB/T 6739-2022

Replacing GB/T 6739-2006

**Paints and Varnishes – Determination of Film Hardness by
Pencil Test**

(ISO 15184:2020, MOD)

色漆和清漆 铅笔法测定漆膜硬度

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Foreword

This document was drafted as per the rules specified in GB/T 1.1-2020 *Directives for Standardization – Part 1: Rules for the Structure and Drafting of Standardizing Documents*.

This Document replaced GB/T 6739-2006 *Paints and Varnishes - Determination of Film Hardness by Pencil Test*. Compared with GB/T 6739-2006, the major technical changes of this Document are as follows besides the structural adjustments and editorial modifications:

- a) Change the “Scope” (see Clause 1 of this Edition; Clause 1 of the 2006 Edition);
- b) Change the "Normative References" (see Clause 2 of this Edition; Clause 2 of the 2006 Edition);
- c) Delete the relevant content of "definition of defects" in the definition of the term pencil hardness (see Clause 3 of the 2006 Edition);
- d) Change the “Principle” (see Clause 4 of this Edition; Clause 4 of the 2006 Edition);
- e) Delete “Required supplementary information” (see Clause 5 of the 2006 Edition);
- f) Change the load exerted by the pencil port on the surface of the paint film (see 5.1 of this Edition; 6.1 of the 2006 Edition); known applicable pencil models and manufacturers (see 5.2 of this Edition; 6.2 of the 2006 Edition); and add relevant contents that can also use the pencil lead in the pen holder (movable/automatic pencil) (see 5.2 of this Edition);
- g) Delete the relevant content that can also use the drawing eraser to clean the template (see 6.5 of the 2006 Edition);
- h) Change the "Operating Procedures" (see Clause 8 of this Edition; Clause 9 of the 2006 Edition);
- i) Add "Defect Type" (see Clause 9 of this Edition);
- j) Change "Precision" (see Clause 10 of this Edition; Clause 10 of the 2006 Edition);
- k) Change the "Test Report" (see Clause 11 of this Edition; Clause 11 of the 2006 Edition);
- l) Change the content of "Required Supplementary Information" (see Appendix B of this Edition; Appendix A of the 2006 Edition).

This Document modified and adopted ISO 15184:2020 *Paints and Varnishes - Determination of Film Hardness by Pencil Test*.

Compared with ISO 15184:2020, this Document made the following structural adjustments:

- Appendix B corresponded to Appendix A in ISO 15184:2020.

Paints and Varnishes – Determination of Film Hardness by Pencil Test

IMPORTANT TIPS: The electronic version of this Document contains color content that is intended to assist in the correct understanding of this Document. Therefore, users should consider using a color printer to print this Document.

1 Scope

This Document specifies a method for determining the hardness of paint films by pushing a pencil of known hardness across the film.

This Document is applicable to the determination of the paint film hardness of a single coating of paints, varnishes and related products; and is also applicable to the determination of the paint film hardness of the top layer of a multi-coating.

This Document is not applicable to comparing the pencil hardness of different paint films. This Document is applicable to providing a relative rating of a series of painted test panels with significant differences in pencil hardness.

This Document is only applicable to the determination of paint film hardness on smooth surfaces.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 3186 Paints varnishes and raw materials for paints and varnishes – Sampling (GB/T 3186-2006, ISO 15528:2000, IDT)

GB/T 9271 Paints and varnishes standard panels for testing (GB/T 9271-2008, ISO 1514:2004, MOD)

GB/T 13452.2 Paints and varnishes - Determination of film thickness (GB/T 13452.2-2008, ISO 2808:2007, IDT)

GB/T 20777 Paints and varnishes - Examination and preparation of samples for testing

(GB/T 20777-2006, ISO 1513:1992, IDT)

GB/T 37356 Paints and varnishes - Lighting and procedure for visual assessments of coatings (GB/T 37356-2019, ISO 13076:2012, IDT)

ISO 4618 Paints and varnishes – Terms and definitions

NOTE: GB/T 5206-2015 Paints and varnishes – Terms and definitions (ISO 4618:2014, IDT)

3 Terms and Definitions

For the purposes of this Document, the following terms and definitions given in ISO 4618 apply.

ISO and IEC maintain terminology databases used for standardization work at:

--- ISO online browsing platform: available from <https://www.iso.org/obp>;

--- IEC Electrical Encyclopedia: Available from <http://www.electropedia.org/>.

3.1 Pencil hardness

The ability of a paint film surface to resist scratches or other defects when a pencil of specified size, shape and pencil lead hardness is pushed across the paint film surface.

4 Principle

Use a pencil lead with a specified geometric shape to press down on the surface of the paint film at an angle of 45° under a load of (7.35 ± 0.15) N; and measure the pencil hardness of the paint film by pushing the pencil on the paint film. Gradually increase the pencil hardness until visible defects appear on the surface of the paint film. The pencil hardness of the paint film is expressed as the hardness of the hardest pencil that does not cause defects in the paint film.

5 Apparatus

5.1 The test instrument consists of a metal block with a wheel on each side, as shown in Figure 1. The used wheel shall not scratch the surface of the paint film during the measurement process. In the middle of the metal block, there is a cylindrical hole inclined at an angle of $(45 \pm 1)^\circ$ for holding a pencil.

With the help of the clamp, the pencil is fixed to the instrument and always remains in the same position.

A level instrument is installed on the top of the instrument to ensure the level of the instrument

7 Test Panel

7.1 Substrate

Unless otherwise agreed, the substrate specified in GB/T 9271 shall be selected; and the same type of material as that used in actual use shall be selected as much as possible. The substrate should be flat and without deformation.

7.2 Shape and size

The shape and size of the test panel shall ensure that the test panel remains level during the test.

7.3 Treatment and coating

Unless otherwise agreed, each test panel shall be treated according to the provisions of GB/T 9271; and then coated with the tested product or system according to the prescribed method.

7.4 Drying and conditioning

Each painted test panel is dried (or baked) under the specified conditions and stand (if applicable) for the specified time. Unless otherwise agreed, before testing, the test panel shall be conditioned at a temperature of $(23\pm 2)^{\circ}\text{C}$ and a relative humidity of $(50\pm 5)\%$ for at least 16h.

7.5 Paint film thickness

Paint film thickness shall be specified or agreed upon. The paint film thickness is measured according to one of the dry film thickness measurement methods specified in GB/T 13452.2.

8 Operation Procedure

8.1 Unless otherwise agreed, the test shall be carried out under the conditions of temperature $(23\pm 2)^{\circ}\text{C}$ and relative humidity $(50\pm 5)\%$.

8.2 Use a special mechanical pencil sharpener (5.3) to cut off 5mm~6mm of wood from one end of each pencil; and operate carefully to make the pencil lead in an original, unscratched, smooth cylindrical state.

8.3 Hold the pencil vertically; maintain an angle of 90° with the sandpaper; and move the pencil back and forth on the sandpaper (5.4) to smooth the pencil lead port. Keep moving the pencil until a flat, smooth round cross-section is obtained without chips or gaps around the edges.

Repeat this procedure every time before using the pencil.

8.4 Place the painted test panel on a level, stable surface.

Insert the pencil into the test instrument (5.1) and fix it with a clamp so that the instrument remains level and the port of the pencil is placed on the surface of the paint film (see Figure 1).

8.5 When the port of the pencil just touches the paint film, immediately push the pencil away from the operator at a slow and even speed, and push it far enough for visual judgment.

8.6 Unless otherwise agreed, observe the surface of the paint film after 30 seconds with normal corrected vision under natural sunlight or artificial sunlight specified in GB/T 37356, and check whether defects defined in Clause 9 appear.

Wipe the surface of the paint film with a soft cloth or cotton swab (5.5) dipped in a solvent that has no effect on the paint film. Defects will be easier to assess after all pencil lead debris on the paint film surface is wiped off. Care should be taken that solvents do not affect the hardness of the paint film in the test area.

After agreement, a magnifying glass with a magnification of 6 times to 10 times can be used to evaluate defects. If a magnifying glass is used, this shall be indicated in the report.

If no defects appear, replace the pencil with a higher hardness in the untested area and repeat the test (8.3~8.6) until defects of at least 3mm appear.

If defects have occurred, reduce the hardness of the pencil and repeat the test (8.3~8.6) until defects no longer occur.

It is determined that a defect of some type as defined in Clause 9 has occurred.

The pencil hardness of the paint film is expressed as the hardness of the hardest pencil that does not cause defects in the paint film.

8.7 Measure twice in parallel. If the two measurement results differ by one pencil hardness grade, use the hardness of the harder pencil to represent the pencil hardness of the paint film. If the two measurement results differ by more than one pencil hardness grade, discard and retest.

9 Type of Defect

Scratching the paint film surface with a pencil lead will produce a series of defects on the paint film surface.

These defects are defined as follows:

- a) Plastic deformation: permanent indentation on the surface of the paint film, but no cohesive damage;
- b) Cohesive damage: Visible abrasions or scratches appear on the surface of the paint film, and debris falls off the paint film;

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