

Standard Test Method for Film Hardness by Pencil Test¹

本标准以固定名称代码 D3363 发布，紧接着名称后的数字表示的是通过该标准的原始时间或是修订该标准的最近年限。括号内的数字表示最新重审批准的年限。上标中的希腊文字表明的是最新修订本或重审批准的编辑修订。This standard is issued under the fixed designation D 3363; 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 re-approval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or re-approval.

1. 范围 Scope

- 1.1 该测试方法能够快速，经济的从已知绘画铅笔或石墨铅笔的硬度来测定有机涂层对基板的漆膜硬度。
This test method covers a procedure for rapid, inexpensive determination of the film hardness of an organic coating on a substrate in terms of drawing leads or pencil leads of known hardness.
- 1.2 该测试方法与ISO15184 所包含的内容相似（但从技术上不等同）
This test method is similar in content (but not technically equivalent) to ISO 15184.
- 1.3 在国际单位上的数值被认为是一个标准，括号中的数值仅供参考。
The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.
- 1.4 本标准不承诺解决所有安全问题。如果有，则与它的使用有关。该标准使用者有责任在使用之前制定合适、安全、健康的条例，测定管理局限性的适用性。
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. 参考文件 Referenced Documents

2.1 其它标准 Other Standards:

- ISO15184 铅笔试验测定漆膜硬度方法^[2]
- ISO 15184, Determination of film hardness by pencil test².

3. 测试方法概要 Summary of Test Method

- 3.1 将带涂层的面板水平放置于漆膜表层。铅笔呈45度角的方向固定于与漆膜对面（操作人员远离该点），并推铅笔在离操作员6.5mm (1/4 英寸)处划动。该过程是最硬的铅笔开始并逐渐减小其硬度，如只达到以下两点中的一点即终止测试：其一， 铅笔不可削得太尖以免刻伤漆膜（关于铅笔硬度）；其二， 铅笔不能划伤漆膜（关于划痕硬度）。
A coated panel is placed on a firm horizontal surface. The pencil is held firmly against the film at a 45° angle (point away from the operator) and pushed away from the operator in a 6.5-mm (1/4-in.) stroke. The process is started with the hardest pencil and continued down the scale of hardness to either of two end points: one, the pencil that will not cut into or gouge the film (pencil hardness), or two, the pencil that will not scratch the film (scratch hardness).

4. 重要性和用途 Significance and Use

- 4.1 铅笔硬度测试的方法被长期广泛的运用于涂层工业，用于测试表面涂有洁净、着色、有机涂料漆膜的硬度。

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决方法，尤其是当使用热干燥时。

is used by the coatings industry for many years to determine the hardness of clear and pigmented organic coating films. This test method has also been used to determine the cure of these coatings, especially when forced dried using heat.

- 4.2 在一个独立的实验室，这种测试方法对于进展中的工作和生产控制测试来说，是特别有效的。我们必须认识到测试结果将可能随着在不同实验室用不同的铅笔做测试而变化，就像面板的使用一样，我们应做出一切努力以标准要求使用的力度，以及其所带来的相关技术方法。

This test method is especially useful in developmental work and in production control testing in a single laboratory. It should be recognized that the results obtained may vary between different laboratories when different pencils as well as panels are used. Every effort should be made to standardize the hardness of the lead used and the technique followed.

- 4.3 如果这个试验方法是用于作为采购协议的基础，那么当买卖双方认同其一组特裁铅笔而形成协议时其采购协议将达到最高的精度。

If this test method is used as a basis for purchase agreement, maximum precision will be achieved if a given set of referee pencils be agreed upon between the purchaser and the seller.

5. 装置 Apparatus

- 5.1 一套校准的绘画笔芯（推荐）或等效的木质校准铅笔，需满足以下硬度的刻度：

A set of calibrated drawing leads (preferred) or equivalent calibrated wood pencils meeting the following scale of hardness:

6B25B24B23B22B2B2HB2F2H22H23H24H25H26H

软件 Softer

硬件 Harder

(1)

临近的两个不同笔心可视为同一硬度单位。

The difference between two adjacent leads shall be considered one unit of hardness.

- 5.2 测试过程中请使用机械持笔器固定绘画铅笔。

Mechanical Lead Holder, for drawing leads if used.

- 5.3 测试过程中使用机械削笔，草拟模型有助于调整木质铅笔。

Mechanical Sharpener, draftsman-type, is helpful for trimming wood pencils if used.

- 5.4 准备砂纸和NO400沙砾。

Abrasive Paper, grit No. 400.

6. 测试样品和条件 Test Specimens and Conditions

- 6.1 将涂料适当的涂在平滑的、坚硬的漆膜底部并适当的应用，或使用从有涂料的托盘上取下具有代表性的面板。在测试之前，使用的面板、消除条件以及涂料的使用年限必须在买卖双方认同的最低限度之内。

Apply the surface coating by appropriate means to a smooth rigid substrate and cure properly, or use representative panels cut from coated stock. The panels used, the curing conditions, and the age of the coating prior to the test shall be within the limits agreed upon between the purchaser and the seller.

- 6.2 漆膜涂层的厚度必须是买卖双方指定的或是双方认同的。

The film thickness of the coating shall be as specified or as agreed upon between the purchaser and the seller.

- 6.3 该测试应在温度为23.62°C (73.5 63.5°F)，相对湿度为50.65%下进行。

Conduct the test at 23.6 2°C (73.5 6 3.5°F) and 50.65 % relative humidity.

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7.1 木质铅笔，从木头尖端削除约5 ~ 6mm (3/6 ~ 1/4英寸) 的木头。小心的使用机械削笔器削出完整的、无划痕、光滑的圆柱型笔心。在于砂纸呈90度角的方向使用持笔器，在保持与砂纸呈90度的方向摩擦砂纸，直至画出平整光滑的圆形截面，在圆形截面内不得存在碎片或刻痕，木质铅笔参照图1说明，画笔的持笔器参照图2说明。将砂纸同电动圆盘粘合得到我们想要的截面边缘，将铅笔置于与圆盘呈90度的位置更能重复获取扁平均匀的铅笔芯。

For wood pencils, remove approximately 5 to 6 mm (3/6 to 1/4 in.) of wood from the point of each pencil using a draftsman-type mechanical sharpener, being careful to leave an undisturbed, unmarked, smooth cylinder of lead. Holding the pencil holder (when using drawing leads) at an angle of 90° to the abrasive paper, rub the lead against the paper maintaining an exact angle of 90° to the abrasive paper until a flat, smooth and circular cross section is obtained, free of chips or nicks in the edge of the cross section. For wood pencils, see Fig. 1 for an illustration. For mechanical pencil holders with drawing leads, see Fig. 2 as the illustration. The desired edge may be obtained by cementing the abrasive paper to a flat motor-driven disk. By supporting the pencil at 90° to the rotating disk a uniform flat lead end may be obtained more reproducibly.

7.2 木质铅笔，从木头尖端削除约5 ~ 6mm (3/6 ~ 1/4英寸) 的木头。小心的使用机械削笔器削出完整的、无划痕、光滑的圆柱型笔心。在于砂纸呈90度角的方向使用持笔器，在保持与砂纸呈90度的方向摩擦砂纸，直至画出平整光滑的圆形截面，在圆形截面内不得存在碎片或刻痕。将砂纸同电动圆盘粘合得到我们想要的截面边缘，将铅笔置于与圆盘呈90度的位置更能重复获取扁平均匀的铅笔芯。

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7.3 将带涂层的面板水平放置于漆膜表层。铅笔呈45度角的方向固定于漆膜对面（操作人员远离该点），并将铅笔推离操作人员。向下或向前施加足够的压力，使漆膜划伤或是铅笔芯边缘碎裂。划动长度最好为6.5mm (1/4英寸)。

Place the coated panel on a level, firm, horizontal surface. Starting with the hardest lead, hold the pencil or lead holder firmly with the lead against the film at a 45° angle (point away from the operator) and push away from the operator. Exert sufficient uniform pressure downward and forward either to cut or scratch the film or to crumble the edge of the lead. It is suggested that the length of the stroke be 6.5 mm (1/4 in.).

7.4 重复试验步骤，直至铅笔无法穿过漆膜距离底部（金属或是原先的涂层）3mm (1/8英寸) 处。（见8.1.1）。Repeat the process down the hardness scale until a pencil is found that will not cut through the film to the substrate (either metal or a previous coat) for a distance of at least 3 mm (1/8 in.) (See 8.1.1).

备注 1: 操作人员必须仔细观察铅笔是刺穿还是划伤漆膜。一些试验的最后阶段包含了漆膜润滑的混合物。需近距离目测及用手指甲触摸。

NOTE 1- the operator must watch closely for cutting into or scratching the film. Some finishes contain compounds that may tend to lubricate the film. Checks should be made by close visual inspection and by fingernail feel.

备注 2: 在操作试验的过程中，如果笔芯的笔尖边缘稍微出现缺口或碎裂，笔芯必须重新消磨。

NOTE 2- in conducting the test, if the sharp edge of the lead is slightly chipped or crumbled, the lead must be re-sharpened.

7.5 继续过程重复试验，直至铅笔无法穿过或触及漆膜表面，只有对漆膜的损毁才被认为是划伤而不仅仅是穿过或是划一下。记录每个凿痕和划痕硬度的端点，如果适用。（见8.1）

Continue the process until a pencil is found that will neither cut through nor scratch the surface of the film. Any defacement of the film other than a cut (gouge) is considered a scratch. Record each end point (if applicable) for gouge and scratch hardness (see 8.1).

一致。
Points will be identical.

7.6 为每根铅笔或笔芯和测试凿痕和划痕硬度做两个最小型的测试。

Make a minimum of two determinations for gouge hardness (7.4) and scratch hardness (7.5) for each pencil or lead.

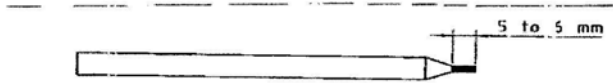
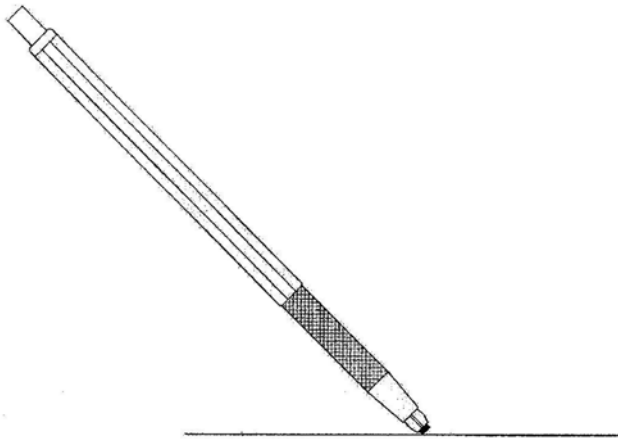


Figure 2: Schematic view of pencil after sharpening

图示1 削除后的木质铅笔

FIG. 1 View of Wood Pencil after Sharpening



图示2 削尖画笔的持笔器

FIG. 2 View of Mechanical Holder with Sharpened Drawing Lead

8. 报告 Report

8.1 报告以下信息: Report the following information:

8.1.1 如下两个端点: The two end points as follows:

8.1.1.1 凿痕硬度δ 在距离至少3mm (1/8英寸) 处最硬的铅笔不会划伤漆膜。

Gouge Hardness- the hardest pencil that will leave the film uncut for a stroke length of at least 3 mm (1/8 in.).

8.1.1.2 划痕硬度δ 最硬的铅笔不会使漆膜裂开或划伤。

Scratch Hardness- the hardest pencil that will not rupture or scratch the film.

8.1.2 使用的笔芯或铅笔的等级。

The make and grade of lead or pencil used, and

8.1.3 最后阶段的任何偏差包括粗糙度

Any deviation from standard conditions, including roughness in the finish.

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9.1 精确度 δ 在多个实验室中, 重复使用该测试方法在面板上的3个不同漆膜, 10个实验室和操作人员, 以及铅笔和面板的交替变化, 实验室内部0.52的标准差及实验室间0.61的偏差进行测试, 在这些标准偏差的基础上, 以下准则95%能判断实验结果的可信度:

Precision- in an inter-laboratory test of this test method with three different films on panels, ten laboratories and operators, and repeated by switching leads and panels between laboratories, the within-laboratory standard deviation was found to be 0.52 and the between-laboratory standard deviation was found to be 0.61. Based on these standard deviations, the following criteria should be used for judging the acceptability of results at a 95 % confidence level:

9.1.1 可重复性 δ 两个操作人员在同一个实验室使用同一铅笔、同一面板测出两个结果, 如果超过两个铅笔组的试验结果不同, 实验结果不可信 (如5.1所述)。

Repeatability- two results obtained by two operators within a laboratory using the same pencils and panels should be considered suspect if they differ by more than one pencil unit on the scale described in 5.1.

9.1.2 可再现性 δ 操作人员在不同的实验室使用同一铅笔、同一面板或是不同铅笔、同一面板测出两个结果, 每个结果至少出现2个偏差, 如果超过两个铅笔组的试验结果不同, 实验结果不可信 (如5.1所述)。

Reproducibility- two results, each the mean of at least two determinations, obtained by operators in different laboratories using the same pencils and panels or different pencils with the same panels should be considered suspect if they differ by more than one pencil unit on the scale described in 5.1.

9.1.3 偏差 δ 由于该铅笔硬度的测试方法没有可接受的材料适宜于测定过程的偏差, 因此偏差尚不能定。

Bias- since there is no acceptable material suitable for determining the bias for the procedure in this test method for measuring pencil hardness, bias cannot be determined.

10. 关键词 **Keywords**

10.1 硬度 (划痕): 铅笔硬度。

Hardness (scratch); pencil hardness

SUMMARY OF CHANGES

Committee D01 has identified the location of selected changes to this standard since the last issue (D 3363 . 00) that may impact the use of this standard.

(1) **Figs. 1 and 2** were added to make it clearer to the user of this standard how the trimmed wood from wood pencil and geometry of the lead tip should appear.

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1. This method is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.23 on Physical Properties of Applied Paint Films. Current edition approved Jan. 1, 2005. Published February 2005. Originally approved in 1974. Last previous edition D approved in 2000 as D 3363 . 00.
2. Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.