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**Paints and varnishes — Determination
of scratch resistance —**

**Part 2:
Variable-loading method**

*Peintures et vernis — Détermination de la résistance à la rayure —
Partie 2: Méthode à charge variable*



Reference number
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Contents

	Page
Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Apparatus	2
6 Sampling	3
7 Test panels	3
7.1 Substrate	3
7.2 Preparation and coating	4
7.3 Drying and conditioning	4
7.4 Thickness of coating	4
8 Procedure	4
8.1 Test conditions	4
8.2 Preparation for the test	4
8.3 Determination	4
9 Expression of results	5
10 Precision	5
11 Test report	6
Bibliography	7

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 1518-2:2011), which has been technically revised. The main changes compared to the previous edition are as follows:

- [Clause 3](#), Terms and definitions, has been added;
- [Clauses 7](#) and [10](#) have been aligned with ISO 1518-1.

A list of all parts in the ISO 1518 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paints and varnishes — Determination of scratch resistance —

Part 2: Variable-loading method

1 Scope

This document specifies a method for determining, using a pointed stylus loaded with a continuously increasing load, the scratch resistance of a single coating of a paint, varnish or related product, or the upper layer of a multicoat system.

This test has been found to be useful in comparing the scratch resistance of different coatings. It is most useful in providing relative ratings for a series of coated panels exhibiting significant differences in scratch resistance.

NOTE Neither this document nor ISO 1518-1 specifies a method using a curved stylus, which is specified in ISO 12137. The choice between the three methods will depend on the particular practical problem.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1513, *Paints and varnishes — Examination and preparation of test samples*

ISO 1514, *Paints and varnishes — Standard panels for testing*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 4618, *Paints and varnishes — Terms and definitions*

ISO 15528, *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Principle

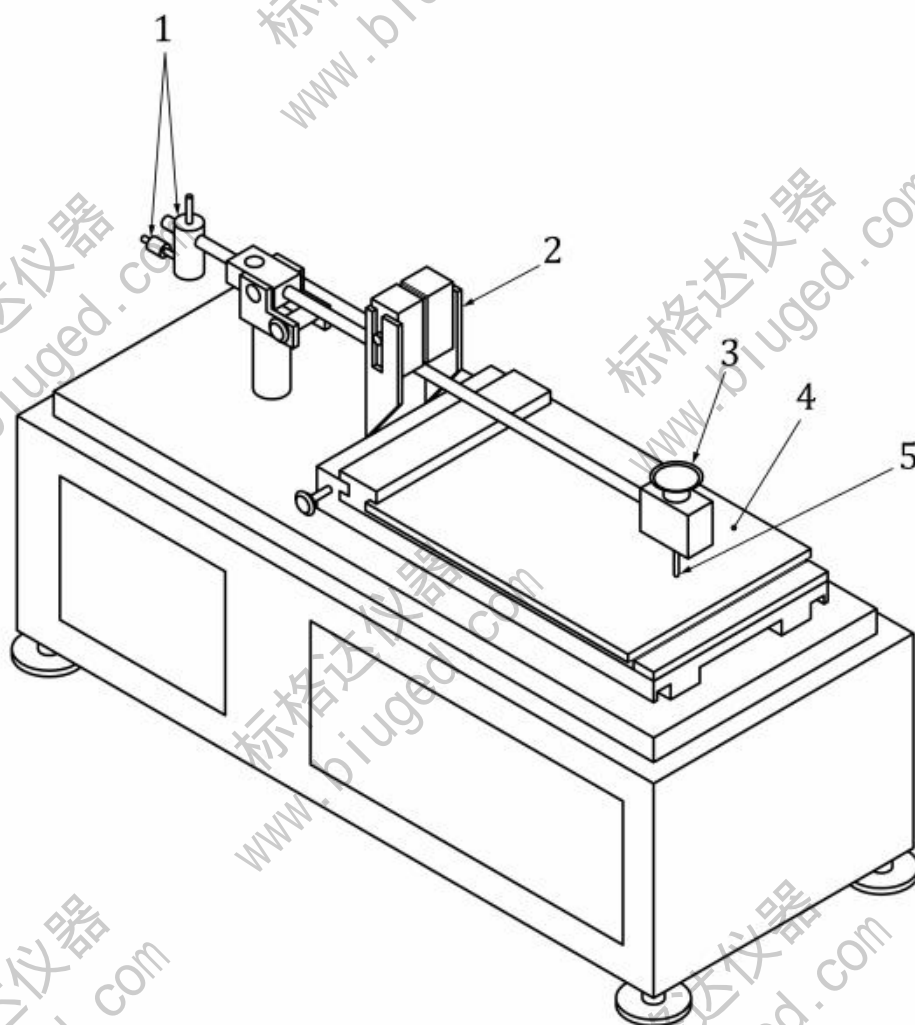
The product or system under test is applied at uniform thickness to flat panels of uniform surface texture. After drying/curing, the scratch resistance is determined using an automatic instrument which pushes the panels beneath a pointed stylus mounted so that it presses down perpendicularly on

the surface of the test panel. The load on the test panel is increased continuously until the coating is scratched.

5 Apparatus

5.1 Instrument for determining scratch resistance.

A suitable instrument¹⁾ is shown in [Figure 1](#). It consists principally of a counterbalanced beam with a pointed stylus mounted at one end. The test panel is placed on a motor-driven sliding table so that it moves under the stylus at a speed of 10 mm/s. A continuous-loading weight mounted over the beam acts on the beam in such a way that, as the test panel passes under the stylus, the load on the stylus is continuously increased.



Key

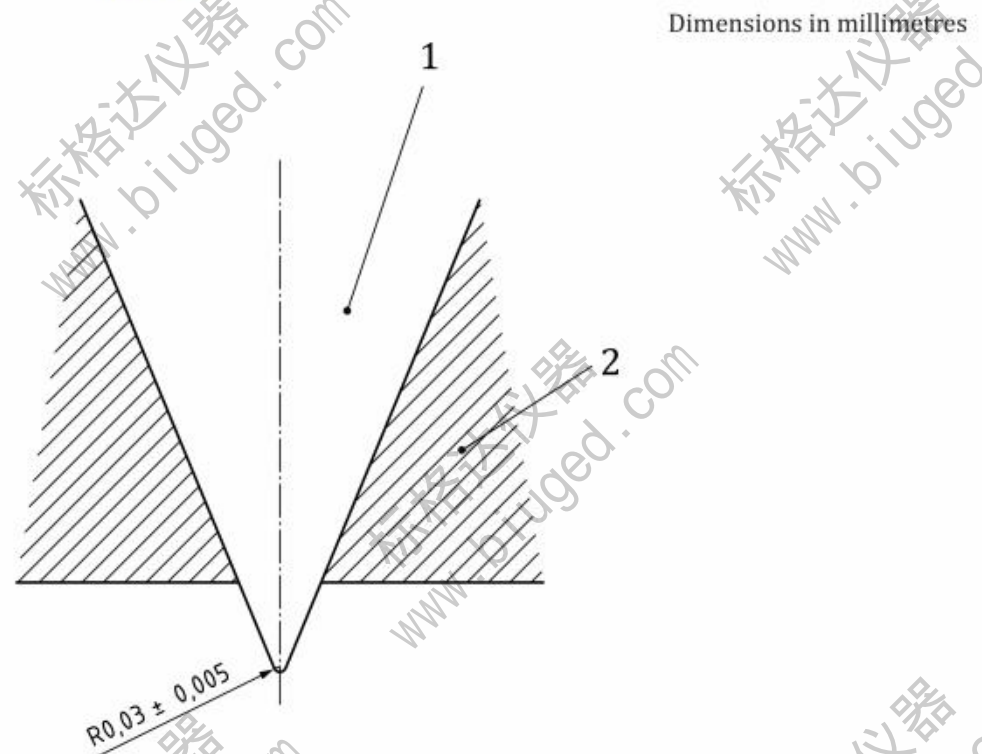
- | | | | |
|---|---------------------------|---|---------------|
| 1 | cylindrical counterweight | 4 | sliding table |
| 2 | continuous-loading weight | 5 | stylus |
| 3 | scale pan | | |

Figure 1 — Scratch instrument with pointed stylus

1) This apparatus is available from Shinto Scientific Co., Ltd, 27 Kanda-higashikonyacho, Chiyoda-ku, Tokyo 101-0034, Japan. This information is given for the convenience of users of this document and does not constitute endorsement by ISO of the apparatus shown. Other types of scratch tester may be used if they can be shown to give similar relative ratings.

The stylus-loading range can be varied by changing the continuous-loading weight (weights giving loading ranges of 0 g to 50 g, 0 g to 100 g and 0 g to 200 g are available, for instance). Mounted over the stylus itself is a small scale pan on which weights can be placed to expand the stylus-loading range (adding a weight of 100 g, for instance, changes a 0 g to 200 g loading range to one of 100 g to 300 g).

5.2 Stylus, preferably tipped with a conical sapphire or diamond, the point of which is rounded to a radius of $(0,030 \pm 0,005)$ mm (see [Figure 2](#)).



Key

- 1 conical sapphire or diamond
- 2 stylus

Figure 2 — Stylus tipped with conical sapphire or diamond

5.3 Microscope, preferably with a magnification range extending up to $\times 100$, required to examine the stylus. It may also be used to inspect the scratched coating.

6 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multicoat system), as specified in ISO 15528.

Examine and prepare each sample for testing, as specified in ISO 1513.

7 Test panels

7.1 Substrate

Select the substrate from one of those specified in ISO 1514 and, where possible, in accordance with the desired practical application. The panels shall be plane and free from distortion, with a maximum thickness of about 12 mm, and 100 mm to 400 mm wide and long.

7.2 Preparation and coating

Prepare each test panel in accordance with ISO 1514 and then coat it by the specified method with the product or system under test.

The method of application of the coating shall be as specified by the manufacturer or agreed between the interested parties and shall be included in the test report [see [Clause 11](#), c) 2)].

7.3 Drying and conditioning

Dry (or stove) and age, if applicable, each coated test panel for the specified time and under the specified conditions. Before testing, condition the coated panels at (23 ± 2) °C and a relative humidity of (50 ± 5) % (i.e. in accordance with ISO 3270) for a minimum period of 16 h. Carry out the test procedure immediately after the removal of the test panels from the conditioning chamber.

The drying (or stoving) and ageing time and conditions shall be as specified by the manufacturer or agreed between interested parties and shall be included in the test report [see [Clause 11](#), c) 3)].

The coated panels shall be stored and handled so as to avoid contamination by fingerprints and dust.

NOTE Fingerprints, dust or other contamination on the surface will result in a lower accuracy.

7.4 Thickness of coating

Determine the thickness, in micrometres, of the dried coating by one of the procedures specified in ISO 2808.

The dry-film thickness shall be as specified by the manufacturer or agreed between the interested parties and shall be included in the test report [see [Clause 11](#), c) 4)].

8 Procedure

8.1 Test conditions

Carry out the test at (23 ± 2) °C and a relative humidity of (50 ± 5) %.

8.2 Preparation for the test

Place the instrument on a stable and level surface.

Level the instrument in accordance with the manufacturer's instructions.

Examine the stylus under the microscope, preferably at a magnification of $\times 100$, in accordance with the instrument operation manual, to ensure that it is undamaged.

Clean the stylus, if necessary, with a clean cloth or lint-free paper.

8.3 Determination

Place a test panel up against the stop on the sliding table. Secure the panel in place by turning the securing screws evenly about one turn at a time.

Secure the stylus in the vertical position.

Adjust the counterweights so that, when the tip of the stylus is just touching the surface of the test panel, the load on the stylus is zero.

Adjust the height of the stylus to the thickness of the test panel, with the beam released and the stylus resting on the test panel.

Load the stylus at the lowest weight range to be tested, e.g. 0 g to 50 g.

Start the instrument at a rate of about 10 mm/s. The instrument shown in [Figure 1](#) will stop automatically when the sliding table has moved 100 mm.

Inspect the coating for scratching under a suitable magnification or with the naked eye.

If no scratching occurs, increase the stylus-loading range, e.g. 0 g to 100 g, and continue in test areas that do not overlap until scratching does occur. When scratching has occurred, determine which type of defect is involved. The defects are defined as follows:

- Plastic deformation: the permanent indentation of the surface with or without any surface blemish or cohesive fracture.
- Surface blemish: a superficial surface effect caused by a difference in the scattering of light between the line of test and the adjacent surface.
- Surface scratch: a continuous cut or gouge through the surface.
- Cohesive fracture: the presence of a visible surface break or rupture.
- Combinations of the above.

NOTE In some cases, one of these types of defect might be of particular importance.

Repeat the determination at least twice (i.e. for a total of at least three determinations) on the same panel at the stylus-loading range at which scratching occurs.

For each of the determinations, measure the distance d , in millimetres, from the final-loading point (i.e. the point where the stylus stops moving) to the point where scratching occurs.

9 Expression of results

For each of the determinations carried out, calculate the critical mass, F_c , expressed in grams, at the point at which scratching just occurs, using [Formula \(1\)](#):

$$F_c = \frac{100-d}{100} \cdot (F_f - F_i) \quad (1)$$

where

d is the distance, expressed in millimetres, from the final-loading point to the point where scratching just occurs;

F_f is the final load, expressed in grams, in the stylus-loading range selected;

F_i is the initial load, expressed in grams, in the stylus-loading range selected.

NOTE Some instruments use a scratch-intensity recorder to determine the load which causes scratching of the paint film.

Calculate the mean critical load for the three determinations made on the test panel. Report the result to the nearest 1 g.

10 Precision

No relevant precision data are currently available.

11 Test report

The test report shall contain at least the following information:

- a) all details necessary to identify the product tested;
- b) a reference to this document (i.e. ISO 1518-2:2019);
- c) all details on preparation of the test panels, including the
 - 1) the material, including thickness and surface preparation of the substrate (see 7.1 and 7.2),
 - 2) the method of application of the test coating to the substrate, including the duration and conditions of drying between coats in the case of a multi-coat system (see 7.2),
 - 3) the duration and conditions of drying (or stoving) of the coating, and the conditions of ageing, if applicable, before testing (see 7.3), and
 - 4) the thickness, in micrometres, of the dry coating and the method of measurement in accordance with ISO 2808, and whether it is a single coating or a multi-coat system (see 7.4).
- d) the temperature and relative humidity during the test, if different from those specified in 8.1;
- e) the type of apparatus used;
- f) the dimensions of the stylus used;
- g) whether scratching was assessed using the naked eye or a microscope and, if a microscope was used, the magnification setting at which it was used;
- h) the results of the test:
 - 1) a description of those of the elements of scratching defined in 8.3 which actually occurred (not all will necessarily occur),
 - 2) the mean critical load, expressed in grams, at which each of these elements of scratching occurred, as specified in Clause 9;
- i) any deviation (by agreement or otherwise) from the test method specified;
- j) any unusual features (anomalies) observed during the test;
- k) the date of the test.

Bibliography

- [1] ISO 1518-1, *Paints and varnishes — Determination of scratch resistance — Part 1: Constant-loading method*
- [2] ISO 12137, *Paints and varnishes — Determination of mar resistance*

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