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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).

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For an explanation on 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 the following URL: 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*.

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Introduction

The determination of the adhesive strength is one of the most important preconditions for evaluating the protective function of coatings.

This document offers a helpful overview for the selection of the test method most suitable for each individual case in regard to the evaluation of the adhesive strength.

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Paints and varnishes — Adhesion of coatings

1 Scope

This document summarises the common methods for evaluating the adhesive strength of coatings on a substrate, which can be another coating beneath or the substrate itself. The test methods and evaluation methods are described in Clauses 4, 5, and 6. In the case of standardized test methods the respective standard is referenced in regard to procedure and evaluation. Annex A compares the methods in the synoptic Tables A.1, A.2, and A.3.

Often the adhesive strength cannot be sufficiently evaluated by means of a single method.

The purely physical methods for measuring the adhesive strength are such in which mechanical quantities (e.g. force or torsion moment) are measured directly.

All other methods are based on the evaluation of behaviour under mechanic stress according to practical conditions. For these methods the viscoelastic properties have a wide influence on the evaluation of the adhesive strength, so that it can only be tested comparatively within one method.

Each method has its specific application. An unsuitable method can lead to false information. All of the test methods for the evaluation of the adhesive strength require a certain routine of the test person, especially in regard to identifying the separation line. For most of the test methods the test results, among other things, depend on the film thickness of the coating to be tested. In addition, for several methods differences between tests on a test sheet and in practice can occur, due to different roughness of the substrate.

Effects of delamination caused by weathering or corrosion influences are not subject of this document.

In case cohesion failures predominantly occur during an adhesive strength test, this is no measure for the adhesive strength. However, information can be given on the protective effect of the coating against corrosion.

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 4618, *Paints and varnishes — Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 and the following 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/

3.1
adhesion
phenomenon of attachment at the interface between a solid surface and another material caused by molecular forces

Note 1 to entry: Adhesion should not be confused with cohesion.

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[SOURCE: ISO 4618:2014, 2.7]

3.2
cohesion
forces that bind a film or coat into an integral entity

Note 1 to entry: Cohesion should not be confused with adhesion.

[SOURCE: ISO 4618:2014, 2.55]

3.3
adhesion failure
detachment of a coating from the substrate caused by external forces

Note 1 to entry: The substrate can be another coating beneath or the working material.

3.4
cohesion failure
loss of coherence within a coating caused by external forces

3.5
adhesive strength
force required to detach a coating from a substrate or another coating

[SOURCE: ISO 4618:2014, 2.8]

3.6
wet adhesive strength
adhesive strength (3.5) immediately after previous exposure to moisture

3.7
separation line
interface in which *adhesion failure* (3.3) occurs

3.8
failure pattern
entirety of the visual coating defects, which are caused by an *adhesive strength* (3.5) test

3.9
failure pattern assessment
classification of a *failure pattern* (3.8) by means of criteria or reference patterns

3.10
failure pattern analysis
quantitative evaluation of a *failure pattern* (3.8) with specification of the relative percentages of area for *adhesion failure* (3.3) and *cohesion failure* (3.4) as well as the separation line(s)

3.11
main separation line
separation line with the largest area

3.12
repeatability conditions
conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time

[SOURCE: ISO 5725-1:1994, 3.14]

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3.13
repeatability limit
r
the value less than or equal to which the absolute difference between two test results obtained under *repeatability conditions* (3.12) may be expected to be with a probability of 95 %

[SOURCE: ISO 5725-1:1994, 3.16]

3.14
reproducibility conditions
conditions where independent test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment

[SOURCE: ISO 5725-1:1994, 3.18]

3.15
reproducibility limit
R
the value less than or equal to which the absolute difference between two test results obtained under *reproducibility conditions* (3.14) may be expected to be with a probability of 95 %

[SOURCE: ISO 5725-1:1994, 3.20]

4 Adhesive strength tests without scratch/cut

4.1 Tests with mechanical stress application on the coating

4.1.1 Pull-off test

— Principle

A uniformly increasing tensile force is applied to a test cylinder (metal cylinder of diameter 20 mm), which is adhered to the coating, until the test cylinder is pulled off. The pull-off strength is determined by calculating the tensile force to pull off the test cylinder and the area of the test cylinder.

The principle of the pull-off test is illustrated schematically in Figure 1.

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