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Paints and varnishes — Wedge-cut method for determination of film thickness (scribe and drill method)

Peintures et vernis — Détermination de l'épaisseur par la méthode d'entaille en coin (Méthode de rayer et de forage)

Reference number
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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Paints and varnishes — Wedge-cut method for determination of film thickness (scribe and drill method)

1 Scope

This International Standard specifies a destructive method for determination of the dry film thickness, in which damage to the coat caused in a definite manner is evaluated microscopically. The method is suitable for almost all coat-substrate combinations and also allows determination of the single film thicknesses of coating systems.

The method cannot be applied or can only be applied with restrictions in case of

— too soft and/or elastic coatings (no recognizable scribe or drill hole can be observed),

— hard (cannot be scribed/drilled) or too soft and/or elastic substrates,

— too low visual contrast between the coating and substrate, and

— film thicknesses that are larger than the depth of field of the measuring microscope.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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.

3.1
substrate
surface to which a coating material is applied or is to be applied

[SOURCE: ISO 4618:2014, 2.244]

3.2
coating
layer formed from a single or multiple application of a coating material to a substrate

[SOURCE: ISO 4618:2014, 2.50.1]

3.3
coating system
combination of all coats of coating materials which are to be applied or which have been applied to a substrate

Note 1 to entry: The actual coating system can be characterized by the number of coats involved.

Note 2 to entry: See also *coating* (3.2).

[SOURCE: ISO 4618:2014, 2.54]

3.4
single coat
part of a coating system

3.5
total film thickness
distance between the surface of the coating and surface of the substrate

3.6
single film thickness
distance between the surface of a single coat and the surface of the coat (substrate) underneath

3.7
dry-film thickness
thickness of a coating remaining on the surface when the coating has hardened

[SOURCE: ISO 2808:2007, 3.5]

3.8
wedge cut
damage to the coating system caused mechanically under the specified angle to the surface and extending into the substrate

Note 1 to entry: The wedge cut can be implemented as a linear scribe or as a conical bore hole.

3.9
wedge-cut image
microscopic image of a wedge cut

3.10
adhesive 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 basic material.

3.11
cohesion failure
loss of cohesion within a coating caused by external forces

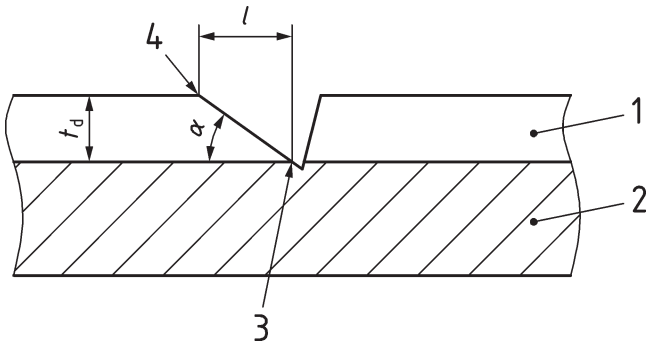
4 Principle

A wedge cut with a known flank angle is made in the coating using a scribing or drilling tool. The film thickness is calculated from the width of the flank projection of the wedge cut obtained with the measuring microscope.

5 Wedge-cut principle

The wedge cut for determination of the film thickness according to this International Standard can be made using a scribing tool (method A) or a drilling tool (method B).

Figure 1 shows a wedge cut according to method A in the cross section. The basis length, *l*, is the projection of the wedge-cut flank within the coating and is measured with a microscope between the upper and lower contrast mark in micrometres.



Key

1 coating
2 substrate
3 lower contrast mark (intersection from the substrate to the coating)
4 upper contrast mark
l wedge-cut basis
t_d dry-film thickness
α wedge-cut angle

Figure 1 — Wedge cut according to method A (single coat/cross section)

The film thickness is determined according to Formula (1):

$$t_d = l \cdot \tan\alpha \quad (1)$$

where

t_d is the dry-film thickness, in micrometres;

l is the wedge-cut base (microscope reading), in micrometres;

$\tan\alpha$ is the wedge-cut factor of the wedge-cut tool used.

NOTE 1 Instruments are available where the microscope reading is indicated in “number of scale divisions” and the wedge-cut factor in “micrometres per scale division”.

NOTE 2 Instruments are available where the microscope reading (in micrometres) for calculating the film thickness is divided by a divisor assigned to the wedge-cut tool.

The film thickness measuring range is as follows:

— determined by the wedge-cut angle, the dimensions of the wedge-cut tool and the scale measuring range of the microscope;

— limited by the depth of field of the measuring microscope (see A.9).

The resolution of the dry-film thickness measurement is determined by the wedge-cut angle and the scale division of the measuring microscope.

EXAMPLE For the usual wedge-cut angles α = 5,7° and α = 14,0°, the following is indicated in Table 1:

— the wedge-cut factor tan α;

— the dry-film thickness measuring range (= scale measuring range × tan α);

— the absolute dry-film thickness resolution Δ_a (= scale division × tan α);

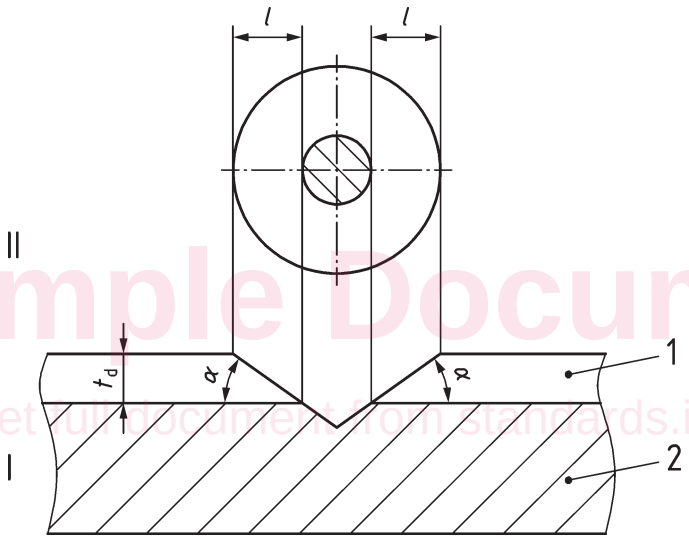
— the relative dry-film thickness resolution Δ_r (= (Δ_a/t_d) × 100; t_d = dry-film thickness).

In the above, it is assumed that the measuring microscope has a scale measuring range of 2 mm, as well as a scale division of 0,02 mm and that the wedge-cut tool is sufficiently dimensioned.

Table 1 — Numerical data on the wedge-cut method

Wedge-cut angle α	°	5,7	14,0
Wedge-cut factor tan α		0,10	0,25
Film thickness measuring range	µm	up to 200	up to 500
Absolute film thickness resolution Δ_a	µm	2	5
Relative film thickness resolution Δ_r	%	200/t_d	500/t_d

Figure 2 shows a wedge cut according to method B in the cross section (I) and the associated wedge-cut image (II) visible through the microscope. Here, the section l to be measured with the microscope is the distance between the concentric circles.



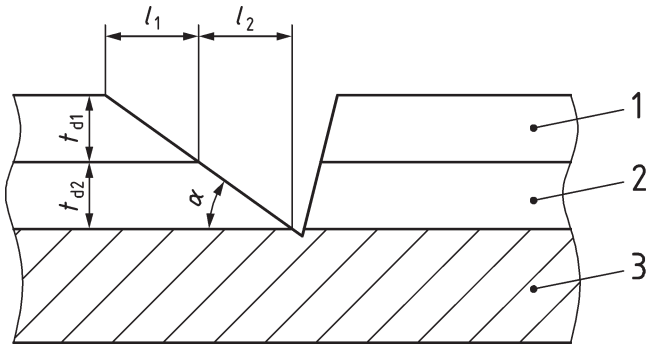
Key

1 cross section
2 wedge-cut image
I coating
II substrate
l wedge-cut basis
t_d dry-film thickness
α wedge-cut angle

Figure 2 — Wedge cut according to method B (single coat)

In the case of coating systems, the single film thicknesses can be determined in a similar manner.

Figure 3 shows the wedge-cut scribe (method A) for a 2-coat system. The single dry-film thicknesses t_{d1} and t_{d2} are then calculated from the microscope readings l_1 and l_2 with Formula (1) for $t_{d1} = l_1 \cdot \tan \alpha$ and $t_{d2} = l_2 \cdot \tan \alpha$.



Key

1 single coat 1
2 single coat 2
3 substrate
l_i wedge-cut basis associated with t_{di} (i = 1, 2)
t_{di} dry-film thickness of the single coat i (i = 1, 2)
α wedge-cut angle

Figure 3 — Wedge cut according to method A (2-coat system/cross section)

6 Apparatus

6.1 Method A

6.1.1 Wedge-cut scribing device, as shown schematically in Figure 4, with the following features.

6.1.1.1 The stylus 6 is fastened interchangeably in the metal block 7 and protrudes as far out as the support bolts 3.

NOTE There are wedge-cut scribing devices that are equipped with support wheels instead of the support bolts.

6.1.1.2 The device shall be adjusted so that, when placed on an even surface, the stylus axis 8 is oriented vertically to this surface.