FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
18947-2**

ISO/TC **42**

Secretariat: ANSI

Voting begins on:
2021-07-02

Voting terminates on:
2021-08-27

Imaging materials and prints — Abrasion resistance —

Part 2: Rub testing of photographic prints

Matériaux pour l'image et les impressions — Résistance à l'abrasion —

Partie 2: Essai de frottement des impressions photographiques

Reference number
ISO/FDIS 18947-2:2021(E)

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Published in Switzerland

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Foreword

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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 42, *Photography*.

This second edition cancels and replaces the first edition (ISO 18947:2013), which has been technically revised.

The main changes compared to the previous edition are as follows:

— visual evaluation was added;

— details of the test procedure have been refined;

— drawings of the test devices have been updated.

A list of all parts in the ISO 18947 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.

Introduction

This method belongs to a series of test methods for the evaluation of permanence and durability of image prints, which refers to the resistance of image prints to physical, mechanical, chemical and/or environmental stresses in conditions of use. The permanence of the image under environmental stresses is tested by each stress factor individually: light (ISO 18937[10]), heat (ISO 18936[9]), ozone (ISO 18941[11]), and humidity (ISO 18946[12]). These stress factors are given by the ambient conditions, over which the user often has limited control. The exposure to mechanical and physical stress may often be controlled by the user, unless intense handling is integral to intended use. Tests for rubbing of prints resulting in abrasion or smearing of the image are handled in the series ISO 18947, scratch resistance is addressed in ISO 18922[7] (for film) and in the series ISO 18951 (all parts) (for reflection prints, currently under development), respectively, and durability tests to simulate accidental exposure to water or food spill is described ISO 18935[8].

The process of rubbing a surface may result in different types of degradation, e.g. abrasion, scuffing, smudging, and others. They may be observed as loss of colour intensity, scratches, changes in gloss, coloration of former uncoloured areas, (coloured) material transfer to a receptor and others.

This document provides standardized requirements to evaluate and quantify the abrasion resistance of image prints in their various formats such as hard copy prints and photo books.

Abrasion and smudge can include both accidental and repeating stresses, resulting from handling of the image. The following are some examples of sources of abrasion:

— dirt particles rubbing on a printed surface;

— sheet-to-sheet abrasion (sliding motion of sheets relative to each other);

— prints sliding on tables or other flat surfaces;

— interaction with dirt or components inside of printers;

— magnets or other items used in the display of images.

This revised edition transforms ISO 18947 into a multipart standard to extend the applicability of this standard to analogue and digital photographic, graphic and office prints. In addition, this revised edition allows for the use of additional types of rub testers. The level of abrasion observed in a test depends on the combination of many factors, including factors of the print material under test as well as the test apparatus.

Different test devices show different levels of rub work, depending on load of the device, relative movement of the samples (direction and speed), test length on the device and the selection of the material and geometry of the abrading receptor.

Material factors that contribute to friction coefficients and therefore influence the susceptibility of printed images to abrasive conditions include surface roughness, surface elasticity, substrate porosity of samples and the chemical formulation, mobility as well as localization of the colorants on the surface or within a receiver layer.

For photographic prints produced with photo-grade papers, a correlation between abrasion results on linear, reciprocating abrasion testers was found in a Round Robin study of TC42/WG5, that included imaging technologies like silver halide, inkjet, electro-photographic and dye diffuse thermal transfer. Together with results from IPI[23][24][25] this Round Robin study serves as background for this document, which is dedicated to (quasi-)linear, reciprocating abrasion test of photographic prints on photo-grade papers, including resin coated (RC photo-grade), barrier coated (water impermeable) paper and coated (water permeable) paper as defined by ISO 18055-1[6], as well as photo-grade films. The term (quasi-)linear considers that the movement on the Sutherland type tester (see ISO 18947-1:—[13], A.2) follows an arc segment of a circle with a large diameter, resulting in a mainly linear motion with a small orthogonal component.

Imaging materials and prints — Abrasion resistance —

Part 2:
Rub testing of photographic prints

1 Scope

This document specifies tests to determine the abrasion resistance of photographic images for typical use in indoor context that is characterized by mild abrasive conditions. Examples are flipping of pages in an album, careful manual handling of prints (stacking, shifting) or use of magnets for attachment to a board. Photographic images refer to individual prints or prints in albums, which can be produced by a wide range of printing technologies, including silver halide, electrophotography, inkjet, dye diffusion thermal transfer, commonly known as dye sublimation, and dye transfer processes. Photographic images require "photo-grade" media, including coated or surface treated print materials, which are prerequisite to obtain photographic quality with aforementioned printing technologies. Test procedures are limited to (quasi-) linear, reciprocal abrasion test devices.

For other printing technologies (e.g. offset lithography and other photomechanical printing processes) or non-photo-grade media or other levels of rubbing representative of other application profiles, different test methods and/or device options may be considered (see ISO 18947-1).

Heavy duty abrasive conditions, such as floor tiles, floor graphics, abrasive cleaning and vehicle graphics, are out of scope of this document.

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 2813, *Paints and varnishes — Determination of gloss value at 20°, 60° and 85°*

ISO 8254-1, *Paper and board — Measurement of specular gloss — Part 1: 75 degree gloss with a converging beam, TAPPI method*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 https://www.electropedia.org/

3.1
abrasion
loss of material from a surface or deformation of a surface, with changes in gloss, colour, or density, due to frictional forces as a result of rubbing

Note 1 to entry: Surface deformations can result in changes in gloss and colour.

3.2
interval scale
<psychophysical> scale established by a psychophysical method, which, in addition to possessing the attributes of *rank order* (3.5), is distinguished by the fact that equal differences between numerical values correspond to equal differences between properties measured (in sensory analysis, perceived intensities)

Note 1 to entry: Larger values correspond to larger perceived intensities and the size of the difference between two values reflects the size of the difference in perceived intensity of the property being measured. However, a numerical value of zero may not indicate a total absence of the property and the ratio of two values cannot be assumed to reflect the ratio of the perceived intensities.

3.3
minimum density
D_{min}
optical density corresponding to the maximum transmittance (film) or reflectance (paper) that a photographic product can achieve

Note 1 to entry: The representation of the minimum density level of a photographic print depends on the printing technology and includes (a) non-printed area of the print material, i.e. a substrate with or without a specific image receiving or image forming layer, (b) coated or printed pre-white area (wherein a white layer is applied before the image is printed such that a coloured or transparent substrate is covered) or (c) a printed area of the material, where a transparent and/or white process colour (e.g. ink or toner) is printed image-wise.

Note 2 to entry: In this document, transparent substrates are evaluated in reflection mode by use of a white or black backing, as suitable.

[SOURCE: ISO 12641-2:2019, 3.6, narrowed to prints observed in reflection mode]

3.4
quasi-linear
<materials testing> curvilinear motion with a small component of total displacement orthogonal to its main direction of movement

Note 1 to entry: The Sutherland type abrasion tester provides an arc motion, where the length of the arc is much shorter than the radius of the circle, resulting in a mainly linear motion with a small orthogonal component.

3.5
rank order
<psychophysical> result of a method involving the arrangement by an observer of a series of stimuli in order of increasing or decreasing image quality or an attribute thereof, in accordance with the set of instructions provided

3.6
ratio scale
<psychophysical> scale established by a psychophysical method, which has the properties of an *interval scale* (3.2) but for which, in addition, the ratio between the values allocated to the two stimuli is equal to the ratio between the perceived intensities of these stimuli

Note 1 to entry: With this scale, a numerical value of zero designates total absence of the property.

Note 2 to entry: The ratio scale is the only case for which it is meaningful to say that one result is, for instance, ten times as great as another.

3.7
receptor
<materials testing> substrate used to rub the test specimen and onto which ink or other material that is removed from the specimen is transferred

Note 1 to entry: An example of a receptor is the back side of the printed media (printed or D_{min} area) being evaluated or a standard reference paper.

3.8
scuff
form of abrasion, leading to a change in gloss

3.9
smudge
result of rubbing leading to the displacement and re-deposition of materials into adjacent areas

Note 1 to entry: see *abrasion* (3.1).

4 General test background

4.1 Summary of practice

This method utilizes a (quasi-)linear, reciprocating rubbing device, or its equivalent, as e.g. described in A.1 or A.2. The test specimen is placed in contact with a receptor surface under a specified load and is rubbed with a back and forth motion at a specified frequency and for a specified number of cycles. A cycle consists of two strokes, namely a forth stroke and a back stroke.

NOTE 1 Devices described in ISO 18947-1:—, A.3 to A.6 were not included in the corresponding inter laboratory test on photographic prints, and therefore it is not known, whether results from those abrasion tests would also provide some level of correlation for selected test parameters.

After treatment, the test specimen is removed from the test device and evaluated for its degree of degradation by measuring the change in gloss, optical density, colour and/or change in physical appearance in both imaged (or printed) and minimum density, D_{min}, areas.

The receptor is analysed for the amount of colorant or coating transferred from the specimen as evidenced by an increase in optical density or change in colour. Results are compared to equivalent, non-abraded specimen and receptor, respectively.

NOTE 2 It is not the purpose of this document to define limits of acceptability or failure.

4.2 Significance and use

Depending upon their intended use applications, abrasion resistance is a desirable and sometimes critical property of imaging materials. The result of abrasion can be degradation in both image quality and appearance, and/or functionality. The amount of abrasion damage to a printed image is dependent on many variables, including the nature of the abrading material, pressure, temperature, and humidity. This method can be used to evaluate the relative abrasion, smudge, and scuff resistance of printed photographic images and unprinted photographic materials under laboratory conditions for simulation of the application profile of photographic images for intended use under “mild” abrasive conditions in typical indoor context, including - but not limited to:

— handling of individual prints (rubbing during stacking, e.g. hand, shoebox, envelope, as well as sliding with fingers);

— photographic images in albums (insertion in corner pieces, page-to-page rubbing);

— photobooks (page-to-page rubbing).

This method provides a reasonably simple procedure that can be used to set specifications for printed photographic materials and determine whether a product meets a predetermined standard for abrasion, smudge, or scuff resistance in aforementioned use.

4.3 Applicability and usage of alternative test methods

For more severe rubbing conditions, alternative test conditions may be more representative of application profile envisaged (see ISO 18947-1).

5 Test device

5.1 Test device description

Test devices suitable for this test are (quasi-)linear, reciprocating abrasion testers as for example shown in A.1 or A.2. Equipment that applies a similar reciprocating abrasive force in a similar manner as described in the preceding standards may also be used[1)].

5.2 Test device preparation

The test device shall be set on a stable laboratory bench, in a room conditioned to the desired test temperature and relative humidity. Conditions of (23 ± 3) °C and (50 ± 10) % relative humidity shall be used for testing, unless specific product end-use requires different conditions.

6 Samples

6.1 Test target definition

Test targets consisting of uniform patches sized to fit the abrasion test device shall be used.

The target shall comprise a specified print substrate, with an associated colour as measured in the minimum density, D_{min}, patch as well as the colour(s) of the imaging material utilized by the printing system under test.

Required colours for test include:

— the 100 % patches of the primary colours, typically cyan, magenta, and yellow, which are addressed by sRGB values (255, 255, 0), (255, 0, 255) and (0, 255, 255), respectively.

— neutral patches (composite black) with sRGB values (0, 0, 0) and secondary colours, typically red, green and blue, addressed by sRGB values (0, 0, 255), (0, 255, 0) and (255, 0, 0), respectively.

Optionally, the following test patches may be tested in addition:

— the D_{min} patch as controlled by the sRGB values (255, 255, 255) – see also Note 1 to entry to term 3.3.

— 100 % patches of any system spots colours, e.g. orange and/or white ink.

— If the printing system makes use of multiple ink levels for a colorant (e.g. cyan and light cyan ink), then a second set of patches of D_{max} may also be included. Further, a third set of patches falling between 0,3 and 0,5 optical densities may also be included.

For monochrome imaging systems (e.g. silver halide, true monochrome inks) the requirements for the test target design collapse into one colour patch, with D_{min} patch and intermediate density patches as optional test.

Each test patch shall be bordered by an adjacent minimum density, D_{min}, area, oriented with the abrasive action of the test instrument, such that the smudging of colorant or imaging media into adjacent minimum density area, D_{min}, can be assessed. Testing of the D_{min} area alone focusses on the abrasive effects of rubbing of the minimum area in the absence of colorant smearing. This may be of

1) Sutherland® Rub Tester (Danilee Co.), AB-301 Color Fastness Rubbing Tester (Tester Sangyo Co., Ltd.), FR-2 (Suga Test Instruments Co., Ltd.), and TRIBOGEAR TYPE 32 (Shinto Scientific Co., Ltd.) are examples of a suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

interest in view of the various constructions of the minimum density area as indicated by the note 1 to term 3.3.

NOTE A test target consisting of a white line, checkerboard, or other high contrast pattern can better characterize smudge. In addition, a crockmeter can be useful in characterizing ink transfer from one surface to another, see e.g. ASTM F 1319[9].

The size of the patches shall be large enough to accommodate the size of the device mountings and weights.

See suitable example of a test target in Annex B.

6.2 Preparation of samples and selection of the receptor material

Samples for abrasion testing shall be printed with test targets defined in 6.1. Samples may also be prints treated at either side (varnished, laminated, bonded, backed, etc.) as in final application.

Samples shall be of a size appropriate for the test device to be used.

The drying time between printing or processing and abrasion testing may influence the results. Printed samples shall be dried or cured and conditioned to the level of intended use prior to rub testing. Shorter times may be tested in addition to investigate susceptibility of the printed images to abrasion by conditions of processing and early handling after printing.

Water-based inkjet-printed samples shall be left face-open under the standard environmental condition at least 14 days prior to rub testing. A shorter conditioning time may be agreed upon when the purpose of the test is to evaluate the abrasion resistance at a shorter time after printing. During drying, curing, and conditioning, dust deposition on the surface to be tested shall be avoided.

The receptor material shall be chosen in view of the intended use: backside of the print substrate (stacking), frontside of another print (pages in an album), a standard receptor material (general purpose). The evaluation of rub on printed receptor surfaces may be difficult. Therefore, standard (unprinted) receptor substrates (recommended for third party evaluation) or back sides of front side printed substrates (to simulate rubbing resistance for real production runs) are recommended.

Samples shall be tested in two directions perpendicular to each other. If there is a proof for non-directionality rub testing in one direction is sufficient.

NOTE Samples can show different properties depending on the test direction. This can be caused by e.g. fibre orientation, texture or others and can cause differences in rub tests. Coated photo-grade print materials tend to have limited directionality.

Both the test specimen and the receptor shall be a flat sample with no surface irregularities, such as scoring or creases.

If testing multiple samples, it is important that each has comparable, if not, identical colorant coverage and colorant density. If the purpose of the test is to compare the print technologies, select appropriate substrates and minimize substrate differences whenever possible.

Care shall be taken to avoid contaminating the sample with fingerprints during handling, as this can influence the test results.

Samples and receptors shall be conditioned at (23 ± 3) °C and (50 ± 10) % relative humidity for 24 h or longer. A shorter conditioning time may be agreed upon when the purpose of the test is to evaluate the abrasion resistance at a shorter time after printing.

If tests need to be performed under different climatic conditions, samples also shall be conditioned in this climate and the conditions shall be recorded.

