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Imaging materials — Scratch resistance of photographic prints —

Part 1: General test method

Matériaux pour l'image — Résistance à la rayure des épreuves photographiques —

Partie 1: Méthode d'essai générale

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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 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*.

A list of all parts in the ISO 18951 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.

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Introduction

This document is one of a series ISO 189xx relating to permanence and durability of image prints, which is the resistance to 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[8]), heat (ISO 18936[7]), ozone (ISO 18941[9]), and humidity (ISO 18946[10]). 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 ISO 18947 (all parts)[11], scratch resistance is addressed in ISO 18922[5] (for film) and durability tests to simulate accidental exposure to water are described ISO 18935[6].

Photographic prints are also susceptible to scratching when handled during their intended use. This problem is particularly evident with digital prints, which may have colorants on the surface without protection from physical damage. The test methods in this document for evaluating the scratch resistance of photographic prints provides another means of characterizing the physical durability of photographic prints.

Scratching tends to occur in a specific location at a single point of contact, as opposed to abrasion which affect larger areas of the print material. And it might occur accidentally or repeatedly by handling of the print.

This document provides standardized requirements to evaluate the scratch resistance of image prints in their various formats. As a test method for scratching, pencil hardness is well-known. However, the pencil test is proved difficult to carry out in a reproducible manner with photographic prints.

In the same point of view, test devices for scratch test show wide variety of the test conditions and parameters. Therefore, the test method and test conditions should be carefully determined taking into account the mechanical stresses that are expected during the use of the printed matter, and also consideration of print material.

This document describes the general guidelines of the scratch test and general considerations for the test device and parameter setting, test sample preparation, general test procedure, assessment of results, reporting requirements and examples of test equipment. The scratch test in this document can be used not only by a printer manufacturer, but also by a system integrator in a printing house to optimize the selection of ink set and substrate combination which will offer strong scratch resistance of the image, or it can be used as an agreeable QC test method between a photo print supplier and their customers, or it could be used by an ink developer to select desirable ingredients that will yield inks with strong scratch resistance, etc. ISO 18951-2[12] describes a specific test method with detailed test parameter selection, test procedure and results assessment for a sclerometer.

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Imaging materials — Scratch resistance of photographic prints —

Part 1: General test method

1 Scope

This document specifies test method, test target, and reporting requirements to determine the scratch resistance of prints with photographic images. Photographic images 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. This document is applicable to prints with paper substrate and other type of substrates including prints on plastic, glass, metal and other materials. This document is applicable to photographic prints that have no protection as well as photographic prints that are protected by a coating or lamination.

It is not the purpose of this document to define limits of acceptability or failure. They would be determined by the user and the intended application.

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 18913, *Imaging materials — Permanence — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 18913 and the following apply.

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology 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
nano scratch
scratch with a testing device using a stylus, which diameter is smaller than 10 µm

Note 1 to entry: An example is a spherical stylus with diameter 2 µm providing a contact area with a diameter of~500 nm.

3.2
micro scratch
scratch with a testing device using a stylus, which diameter is equal or larger than 10 µm and smaller than 0,5 mm

Note 1 to entry: An example is a spherical stylus with diameter 50 µm providing a contact area with a diameter of ~12 µm

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3.3
macro scratch
scratch with a testing device using a stylus, which diameter is equal or larger than 0,5 mm

Note 1 to entry: An example is a spherical stylus with diameter 4 mm providing a contact area with a diameter of ~1 mm or less.

3.4
cohesive failure
breaking that occur inside the boundary between the uppermost layer and the layer underneath or within the uppermost layer, caused when the local stress level introduced by the stylus movement exceeds the yield point of the layers

Note 1 to entry: Cohesive failure is observed as fracture, cracking (forward and rearward), buckling, and flaking on the print surface.

3.5
buckling
deformation of a layer by compression and/or shear upon scratching manifesting itself as local variations of the cross-section of the layer

Note 1 to entry: Analogous observations are bowing of a column of material under compression or wrinkling of a plate under shear

3.6
flaking
cracking and chipping of a layer along the scratch line forming small pieces that flake off

3.7
plastic deformation
permanent distortion that occurs when a material is subjected to tensile, compressive, bending, or torsion stresses that exceed its yield strength and cause it to elongate, compress, buckle, bend, or twist

3.8
adhesive failure
separation between the base material and the coating layers or between different coating layers

4 Principle

4.1 General scratching test method

Typically, scratch resistance is a desirable property of prints and substrates. The degree to which it is required depends on the intended applications of the photographic print. Scratch resistance depends on two main factors, namely the properties of the print and the parameters of the scratching. The scratch test for the print is applied using a stylus which moves relative to the print with a specific force. The vertical load on the stylus tends to cause a surface indentation. During a relative movement of stylus and test surface, compressive/tensile/shear stresses are introduced due to friction. And the stresses tend to result into deformation of the printed layers.

Damage level of the deformation is classified into four levels. The details of the damage levels (level 0 to level 3) are described in 8.2.

The critical load, F_c denotes the minimum load that just causes the specific damage assigned for each level, i.e. $F_{c,1}$, $F_{c,2}$ and $F_{c,3}$ for damage levels 1, 2 and 3, as mentioned before, respectively. The measurement of a critical load is highly dependent on the performance of the equipment. However, "critical load" is useful to compare the test results quantitatively as far as the same kind of the equipment is used.

NOTE 1 The critical load can be determined by constant load method (see 7.3) with stepwise change of load or variable load method (see 7.4)

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