INTERNATIONAL STANDARD

ISO 4582

Third edition
2007-08-01

Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources

Plastiques — Détermination des changements de coloration et des variations de propriétés après exposition à la lumière du jour sous verre, aux agents atmosphériques ou aux sources lumineuses de laboratoire

Reference number
ISO 4582:2007(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 4582 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

This third edition cancels and replaces the second edition (ISO 4582:1998), which has been technically revised.

Introduction

A number of different exposure techniques can be used to provide information on the effects of environmental stresses such as light, heat and water on plastics (see ISO 877 and ISO 4892). Each exposure test has its own particular application and relevance. When determining changes in a particular property or attribute of a material subjected to different exposures, the same evaluation methods should be used after all exposures to ensure meaningful results.

Results for plastics subjected to exposure tests are strongly dependent on the type of exposure conditions used, the type of plastic being tested and the property being evaluated. A result obtained for one property may not be the same as that for a different property of the same material, even if the same exposure test is used. This standard is not intended to establish a fixed procedure for conducting the exposure test, but is intended to provide a set of specific procedures used to express the results for change in a characteristic property of the material after it has been exposed. It is up to the user to determine which exposure conditions are most relevant to the specific material and the service conditions being used.

Test methods should be selected to determine changes in appearance and properties of the exposed material with its proposed application in mind. The exposure test used should be devised to discriminate among materials based on such changes. This standard suggests typical properties that can be used to determine changes in plastics which have been subjected to exposure tests.

NOTE Because of large differences in the spectral distribution of the light sources used, there can be large differences in results for the same plastics exposed in the various devices described in ISO 4892. Therefore, comparisons between plastics should only be made based on results from exposures in the same type of device and under the same conditions. For optimum comparisons, plastics should be exposed at the same time in the same device.

Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or laboratory light sources

1 Scope

This International Standard describes procedures used to determine changes in colour and other appearance properties, and variations in mechanical or other properties, of plastics that have been exposed to daylight behind glass, to natural weathering or to light from a laboratory source. The procedure used to analyse data depends on whether the test used to characterize the materials being exposed is destructive or non-destructive. The exposures are conducted under conditions described in specific exposure standards.

2 Normative references

The following referenced documents are indispensable for the application 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 75 (all parts), *Plastics — Determination of temperature of deflection under load*

ISO 105-A01, *Textiles — Tests for colour fastness — Part A01: General principles of testing*

ISO 105-A02, *Textiles — Tests for colour fastness — Part A02: Grey scale for assessing change in colour*

ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

ISO 178, *Plastics — Determination of flexural properties*

ISO 179 (both parts), *Plastics — Determination of Charpy impact properties*

ISO 180, *Plastics — Determination of Izod impact strength*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527 (all parts), *Plastics — Determination of tensile properties*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20°, 60° and 85°*

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 4628-6, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 6: Assessment of degree of chalking by tape method*

ISO 6603-1, *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 1: Non-instrumented impact testing*

ISO 6603-2, *Plastics — Determination of puncture impact behaviour of rigid plastics — Part 2: Instrumented impact testing*

ISO 6721-1, *Plastics — Determination of dynamic mechanical properties — Part 1: General principles*

ISO 6721-3, *Plastics — Determination of dynamic mechanical properties — Part 3: Flexural vibration — Resonance-curve method*

ISO 6721-5, *Plastics — Determination of dynamic mechanical properties — Part 5: Flexural vibration — Non-resonance method*

ISO 7724 (all parts), *Paints and varnishes — Colorimetry*

ISO 8256, *Plastics — Determination of tensile-impact strength*

ISO 13468-1, *Plastics — Determination of the total luminous transmittance of transparent materials — Part 1: Single-beam instrument*

ISO 14782, *Plastics — Determination of haze for transparent materials*

CIE Publication No. 15, *Colorimetry*

3 Terms and definitions

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

3.1

control

material which is of similar composition and construction to the test material, used for comparison and exposed at the same time as the test material

3.2

file specimen

portion of the material to be tested which is stored under conditions in which it is stable, and is used for comparison between the exposed and the original state

3.3

masked area

portion of the exposed specimen which is protected from light exposure by masking

NOTE The masked area is not protected from heat and moisture.

3.4

test specimen

specific portion of the material upon which the testing is to be performed

3.5

replicate specimens

identical pieces of the test material being evaluated which are all exposed, conditioned and tested at the same time

4 Determination of changes in colour or other appearance attributes

4.1 Changes in colour

4.1.1 Principles

Changes in colour of plastics test specimens exposed in accordance with the specific exposure standard (see Clause 2) are determined by one of the following methods:

a) an instrumental method;

b) visual assessment using a scale.

NOTE The list in Clause 2 is not exhaustive and other standard methods for the determination of properties may also be suitable (see 5.1).

4.1.2 Apparatus

4.1.2.1 Instruments for measuring colour or changes in colour, conforming to the requirements specified in ISO 7724 for opaque specimens. For light-transmitting specimens, instruments shall conform to the requirements of CIE Publication No. 15.

4.1.2.2 Grey scale for assessing change in colour, in accordance with ISO 105-A02 or ISO 105-A03 (see also Annex B to this International Standard). In this scale, grade 1 corresponds to the strongest contrast, and grade 5 to zero contrast (two samples with identical colour).

NOTE The dark grey scale of ISO 105-A02 is well suited to assessing the extent of fading of relatively strong colours or deep shades. The use of the near-white grey scale of ISO 105-A03 may be found preferable for assessing the discolouration, e.g. yellowing, of white or near-white specimens.

4.1.3 Test specimens

Specimens of test and control materials shall conform to the requirements of the appropriate International Standard dealing with the specific exposure method used (see Clause 2 and the Note to 4.1.1). Whenever possible, a control material of known weathering properties shall be included in the exposure experiment. Unless otherwise specified, at least three replicate specimens of each material being exposed shall be used.

4.1.4 Procedure

4.1.4.1 General

The specific procedure used for assessment of colour changes and any surface cleaning shall be agreed upon by all interested parties and shall be included in the test report. Determine colour changes as specified in the appropriate International Standard.

Typically, colour changes are determined at a series of exposure stages in order to evaluate the rate of colour change caused by exposure. In some cases, colour change is determined after a predetermined or specified exposure increment. Measurement or visual assessment of colour should be made as soon as possible after specimens are removed from exposure in order to minimize the effect of dark reactions, although in some cases it is preferable to condition the specimens for e.g. 24 h after removal from exposure as appearance properties assessed just after removal from exposure may vary, depending whether the specimen was removed at the end of a wet exposure period or at the end of a dry exposure period.

NOTE Because of variability in exposure results, comparison of colour changes of different materials is best done when the materials are simultaneously exposed in a single exposure device or at the same exterior location.

4.1.4.2 Instrumental assessment

Measure colour on all specimens before exposure and after each exposure stage. If required, measure colour on file specimens of each material when measuring colour on exposed specimens. Follow the procedures described in ISO 7724 when measuring the colour and determining the colour change of opaque specimens with instruments. For light-transmitting specimens, follow the procedures described in CIE Publication No. 15.

NOTE ASTM E 1347 [3] also describes colour measurement of light-transmitting materials.

4.1.4.3 Visual assessment

Follow the procedure described in ISO 105-A01 when determining colour change by visual assessment. Use a grey scale meeting the requirements of ISO 105-A02 or ISO 105-A03. Compare the contrast rating of the exposed specimen and file specimens using the grey scale. The rating of colour change is the grade on the grey scale which shows the same contrast as between the exposed test specimen and an unexposed file specimen of the same material.

NOTE Current information about suppliers of grey scales can be obtained from the secretariat of ISO/TC 38/SC 1.

If the contrast observed lies between two ratings on the grey scale, it can be characterized by an intermediate rating. For example, a 3-4 rating signifies that, at the given exposure stage, the contrast between the exposed test specimen and the unexposed file specimen is greater than that of rating 4 on the grey scale, but less than that of rating 3.

Report the nature of the colour change in terms of the rating on the grey scale. In addition, the type of colour change shall also be determined and reported. Use the following terms to describe changes in hue, saturation, lightness or combinations of these changes:

a) for hue changes:	more blue or less blue
	more green or less green
	more red or less red
	more yellow or less yellow
b) for saturation changes:	less intense
	more intense
c) for changes in lightness:	lighter
	darker

A typical report of colour change by visual assessment would be as follows: “more yellow, less intense, lighter, ISO 105-A02/A03 grey scale 2-3”.

4.2 Changes in other appearance properties

In addition to colour change, other appearance properties of plastics may change as a result of exposure. Determine changes in these appearance properties in accordance with relevant International Standards. If the method used to assess the property change is not described in an International Standard, include a description of the method used when reporting results. Examples of tests used to determine change in typical appearance properties are shown in Table 1.

Table 1 — Methods used to measure change in typical appearance properties

Property assessed	ISO standard	Quantitative data
Gloss retention	ISO 2813 [a]	yes
Light transmission	ISO 13468-1	yes
Haze	ISO 14782	yes
Chalking	ISO 4628-6 [a]	scale [b]
Mass		yes
Dimensions		yes
Cracking or crazing		scale [b]
Delamination		scale [b]
Warping		scale [b]
Growth of microorganisms		scale [b]
Migration of components to surface		scale [b]

[a] Methods for paints applicable to plastics.

[b] See 6.2.2 for recommended descriptive scale.

5 Determination of changes in mechanical or other properties

5.1 Principles

Surface properties of a plastic can be much more sensitive to changes caused by weathering than bulk properties. Measurement of surface properties, or material properties greatly affected by surface properties, may be more informative in evaluating rigid plastics. The mechanical or other properties measured using destructive tests are determined on several sets of specimens:

a) on specimens selected as representative of the material prior to exposure (initial property determination);

b) on test specimens exposed for a chosen period in accordance with an appropriate International Standard for the specific exposure used;

c) (if required) on file specimens stored in the dark for the same period for which the corresponding test specimens have been exposed.

It is very important that all tests be conducted using exactly the same test procedure and the same specimen-conditioning environment.

Examples of mechanical-property tests which may be used to assess the effect of exposure are shown in Table 2. Such tests yield quantitative data but are destructive so that, if it is required to follow changes through the course of the exposure, an adequate number of replicate test pieces are needed for each exposure increment.

If a property is measured with a non-destructive test, it is recommended that the property be measured on each test specimen prior to exposure and after each exposure increment. Typical properties measured using non-destructive tests include mass, dimensions, surface gloss, transmittance and haze.