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# International Standard



# 4582

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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

*Plastiques — Détermination des changements de coloration et des variations de propriétés après exposition à la lumière naturelle sous verre, aux agents atmosphériques ou à la lumière artificielle*

First edition — 1980-02-01

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[ISO 4582:1980](https://standards.iteh.ai/catalog/standards/sist/4748a946-8e85-4a3c-bc6a-ae8f3e9ad416/iso-4582-1980)

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UDC 678.5/.8 : 678.01 : 535.68

Ref. No. ISO 4582-1980 (E)

Descriptors : plastics, colour fastness, tests, stability tests, environmental tests, daylight tests, artificial light tests.

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4582 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in May 1978.

It has been approved by the member bodies of the following countries :

Australia	Iran	South Africa, Rep. of
Austria	Israel	Spain
Belgium	Italy	Sweden
Bulgaria	Japan	Switzerland
Canada	Korea, Rep. of	Turkey
Czechoslovakia	Mexico	United Kingdom
Finland	Netherlands	USA
France	New Zealand	USSR
Hungary	Poland	Yugoslavia
India	Romania	

No member body expressed disapproval of the document.

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

## 0 Introduction

A number of different exposure techniques have been established to provide information on the effects of exposure on plastics (see ISO 877, ISO 4607 and ISO 4892). Each of these has its own particular application and relevance. However, it is desirable that the procedures for the determination of the changes in colour, appearance, and other properties should be the same whatever exposure is used and that the results should be expressed in a uniform manner; this International Standard has been prepared to meet these requirements. It is the intention that eventually International Standards dealing with the different exposure methods should all invoke the present International Standard. It will then only be necessary for product standards to specify the appropriate exposure method, and choice of properties whose changes are to be determined.

Exposure to light may alter the properties of the material, particularly in the surface layer.

The test methods used to determine changes in properties shall be selected after consideration of the properties of the material which are important in its proposed application. The methods chosen shall be capable of measuring changes in properties with sufficient precision within the ranges which are important in practice, so as to provide significant criteria of change.

A list of possible properties from which a selection may be made is given in annex A.

## 1 Scope and field of application

This International Standard specifies procedures for the determination of changes in colour and appearance and variations in mechanical or other properties of plastics upon exposure to natural or artificial light according to the specific exposure standards.

## 2 References

ISO 105, *Textiles — Tests for colour fastness.*

Section A01, *General principles of testing.*

Section A02, *Grey scale for assessing change in colour.*

ISO 178, *Plastics — Determination of flexural properties of rigid plastics.*

ISO/R 179, *Plastics — Determination of the Charpy impact resistance of rigid plastics (Charpy impact flexural test).*

ISO/R 180, *Plastics — Determination of the Izod impact resistance of rigid plastics (Izod impact flexural tests).*

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

ISO 527, *Plastics — Determination of tensile properties.*

ISO 877, *Plastics — Determination of resistance to change upon exposure under glass to daylight.*

ISO 2579, *Plastics — Instrumental evaluation of colour difference.*<sup>1)</sup>

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

ISO 3557, *Plastics — Recommended practice for spectrophotometry and calculation of colour in CIE systems.*

ISO 3558, *Plastics — Assessment of the colour of near-white or near-colourless materials.*

ISO 4607, *Plastics — Methods of exposure to natural weathering.*

ISO 4892, *Plastics — Methods of exposure to laboratory light sources.*

NOTE — The above list is not exhaustive and other standard methods for the determination of properties can equally well be used (see 4.1).

1) At present at the stage of draft.

### 3 Determination of changes in colour or appearance

#### 3.1 Changes in colour

##### 3.1.1 Principle

Determination of changes in colour of plastics test specimens exposed in accordance with the specific exposure standards (see clause 2),

- a) by visual assessment by means of a contrast scale, or
- b) by instrumental methods.

##### 3.1.2 Apparatus

**3.1.2.1 Grey scale for assessing change in colour** in accordance with the specifications of ISO 105, section A02 (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).

**3.1.2.2 Instrumental means of measuring colour or changes in colour** (see ISO 2579).

##### 3.1.3 Test specimens

The test specimens shall comply with the requirements of the appropriate International Standard dealing with the specific exposure method used (see clause 2).

##### 3.1.4 Procedure

The choice of the visual (3.1.4.1) or instrumental (3.1.4.2) assessment of colour changes shall be made by agreement between the interested parties. Attention is drawn to ISO 2579, ISO 3557 and ISO 3558.

NOTE — The determination of the colour changes may be carried out as specified in the appropriate International Standard for the specific exposure, either

- a) at different exposure stages, or
- b) at a single exposure stage.

##### 3.1.4.1 Visual assessment

Carry out a visual assessment of the colour changes following the principles established in ISO 105, section A01, by comparing, with the rating on the grey scale, as described in ISO 105, section A02, the contrasts existing between the exposed test specimen and the reference test specimen. The rating of colour change is the grade on the grey scale which shows an equivalent contrast to that existing between the exposed test specimen and the reference test specimen.

If the contrast observed lies between two ratings on the grey scale, it will be characterized by an intermediary degree. For example, a 3-4 rating signifies that at the given exposure stage, the contrast between the exposed test specimen and the

reference test specimen is greater than that of rating 4 on the grey scale, but less than rating 3.

Report the nature of the colour change in terms of the rating on the grey scale. The type of colour change shall also be recorded. Thus any changes in hue, purity, lightness or combinations of these changes shall be described by adding terms to the numerical colour rating as follows :

- a) more blue or less blue  
more green or less green  
more red or less red  
more yellow or less yellow } for hue changes
- b) duller  
brighter } for purity changes
- c) lighter  
darker } for changes in lightness

The report will then be of the form, for example, "more yellow, duller, lighter, grey scale 2-3".

##### 3.1.4.2 Instrumental assessment

Instrumental assessment of colour changes is carried out on the test specimen before and after exposure, and, if necessary, on the reference test specimen.

The procedure followed shall be in accordance with the relevant International Standards.

### 3.2 Other visible changes of appearance

In addition to the assessments specified above, any other visible changes to the exposed test specimen may be reported in accordance with relevant International Standards or a note made of visual assessment.

Particular examples of visible change are

- a) variation in transparency, opacity, gloss or matt appearance;
- b) development of cracks, crazes, pits, holes, porous appearance, delamination, warping;
- c) appearance of material easily removed by rubbing, or of exudation.

### 4 Determination of changes in mechanical or other properties

#### 4.1 Principle

Determination of the mechanical or other properties under the same conditions on series of test specimens as follows :

- a) test specimens prior to exposure (initial determination);
- b) test specimens exposed for chosen periods in accordance with the International Standard for the specific exposure used;

c) control specimens stored in the dark for the same period for which the corresponding test specimens have been exposed.

The property or properties to be measured may be specified in the International Standards for the material being tested, or by prior agreement between the interested parties.

The tests for mechanical properties most frequently used are those for tensile properties (see ISO 527, particularly elongation at break) and impact resistance of unnotched specimens (see ISO/R 179) which should detect the onset of embrittlement but other tests may be selected as appropriate (see, for example, ISO 178 and ISO/R 180).

#### 4.2 Apparatus

As described in the appropriate International Standards for the determination of the properties chosen.

#### 4.3 Test specimens

The test specimens shall comply with the requirements of the appropriate International Standard dealing with the specific exposure method used (see clause 2).

NOTE — Exposed specimens may be in the form of a sheet from which the specimens for the particular test have to be cut.

Test specimens are always conditioned after machining (see ISO 2818) but in some circumstances it may be found necessary to precondition the sheets prior to machining to facilitate specimen preparation.

#### 4.4 Procedure

##### 4.4.1 Determination of initial properties

Unless otherwise specified, condition the test specimens for the determination of initial properties in one of the atmospheres and for the appropriate period specified in ISO 291. The particular atmosphere chosen shall be agreed between the interested parties.

Determine the property or properties chosen in accordance with the relevant International Standards or, if these are not available, as agreed between the interested parties (see 4.1).

##### 4.4.2 Storage of control test specimens

Store the control test specimens in the dark under normal laboratory conditions, preferably in one of the standard atmospheres specified in ISO 291.

##### 4.4.3 Determination of the properties at each agreed exposure stage

Condition the exposed test specimens and the appropriate control test specimens (see 4.1) under the same conditions as those used for the determination of the initial properties (see 4.4.1).

Determine the same property (or properties) on both exposed

and control test specimens as was determined on the initial test specimens (see 4.4.1).

NOTE — With some tests, the results depend upon which side of the test specimen is exposed. In bending tests, for example, different results are obtained according to whether the exposed surface or the unexposed surface of the test specimen is placed under tension.

## 5 Expression of results

### 5.1 Changes in colour or appearance

Report the change of colour determined visually (see 3.1.4.1) or by means of instrumental measurements (see 3.1.4.2).

Report the changes of appearance (see 3.2). Changes in appearance and surface properties which have been estimated qualitatively should be expressed on a scale agreed between the interested parties. The following is recommended :

- none;
- barely perceptible;
- moderate;
- substantial.

NOTE — This scale is arbitrary and, although it is of considerable use when assessing several test specimens at the same time, great care is necessary in interpreting results from different observations.

### 5.2 Changes in mechanical and other properties

Determine the mechanical or other properties of each test specimen according to the relevant International Standard.

Then calculate the following arithmetic means :

$\bar{x}_1$  : Arithmetic mean of initial property values.

$\bar{x}_2$  : Arithmetic mean of property values of exposed test specimens at a particular exposure stage.

$\bar{x}_0$  : Arithmetic mean of property values of control test specimens stored in the dark for the same period as that for which the corresponding test specimens have been exposed.

Where applicable, numerical results on exposed test specimens are preferably expressed as percentages of both the initial property value and of the property values of control test specimens that have been stored in the dark for the same period of time as the exposure period of the exposed test specimens.

$$\text{either } \frac{\bar{x}_2}{\bar{x}_1} \times 100, \text{ or } \frac{\bar{x}_2}{\bar{x}_0} \times 100$$

For some properties, for example change of mass or dimensions, results are more conveniently expressed in the form of change of property, i.e.

either  $\frac{\bar{x}_2 - \bar{x}_1}{\bar{x}_1} \times 100$ , or  $\frac{\bar{x}_2 - \bar{x}_0}{\bar{x}_0} \times 100$

NOTE — It may also be advantageous to plot the curve of change in property against time, but in many cases a considerable spread of results may be obtained within each set of test specimens and unless this is taken into account, misleading conclusions may be drawn from a plot of arithmetic means.

## 6 Test report

The test report shall include the following particulars :

- a) reference to this International Standard;
- b) complete identification of the product tested;
- c) information relating to the exposure (type, exposure stage, etc., stating, where appropriate, the relevant International Standard);
- d) the test methods and conditioning procedures used (where appropriate, by reference to the relevant International Standard);
- e) colour change and other modifications of the appearance at each exposure stage used (see 3.1.4);
- f) the individual values and their arithmetic mean from the determination of initial properties;
- g) the individual values and their arithmetic mean from the determination of the properties of exposed test specimens and of control test specimens at each exposure stage used;
- h) the change in the properties at each exposure stage used, stating which manner of expressing the results has been used (see clause 5).

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## Annex A

### Some properties which may be determined to assess change after exposure

#### A.1 Appearance and surface properties

- Colour
- Gloss
- Haze (of transparent materials)
- Chalking
- Blooming, exudation
- Biological attack
- Crazeing and cracking
- Warping
- Delamination

#### A.2 Mechanical properties

- Tensile properties (particularly elongation at break)
- Flexural properties
- Impact strength
- Tear strength

#### A.3 Other properties

- Length, width and thickness
- Change of mass
- Density
- Loss tangent
- Dielectric breakdown voltage
- Surface resistivity
- Volume resistivity
- Vicat softening temperature
- Temperature of deflection under load
- Molecular mass or related properties (for example melt flow rate)
- Chemical changes (for example determined by spectroscopy)

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## Annex B

### Suppliers of grey scales

The grey scale for assessing change in colour can be obtained from the following organizations :

British Standards Institution  
BSI Sales Office  
10 Blackfriars Street  
MANCHESTER M3 5TD  
England

Society of Dyers and Colourists  
P.O. Box 244, Perkin House  
82 Gratton Road  
BRADFORD BD1 2JB  
West Yorks  
England

Beuth-Vertrieb GmbH  
Burggrafenstrasse 4-7  
D 1000 BERLIN 30  
Germany, F.R.

Association pour la détermination de la solidité  
des teintures et impressions sur textiles  
12, rue d'Anjou

F 75008 PARIS  
France

Eidgenössische Materialprüfungs-und Versuchsanstalt  
Unterstrasse 11  
CH 9000 ST GALLEN  
Switzerland

Japanese Standards Association  
1-24 Akasaka 4  
Minatoku-Ku  
TOKYO  
Japan

American Association of Textile Chemists and Colorists  
P.O. Box 12215  
Research Triangle Park  
NORTH CAROLINA 27709  
USA

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