

Methods of testing

Plastics —

Part 5: Optical and colour properties,
weathering —

Method 540B: Methods of exposure to
laboratory light sources, (xenon arc
lamp, enclosed carbon arc lamp,
open-flame carbon arc lamp,
fluorescent tube lamps) —

[ISO title: Plastics — Methods of
exposure to laboratory light sources]

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National foreword

This method has been prepared under the direction of the Plastics Standards Committee and is identical with ISO 4892-1981 “*Plastics — Methods of exposure to laboratory light sources*” published by the International Organization for Standardization (ISO). It replaces method 507B of BS 2782:1970 which is being withdrawn.

Terminology and convention. The text of the international standard has been accepted as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

The comma has been used throughout as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Wherever the words “International Standard” appear, referring to this standard, they should be read as “British Standard”.

Cross-references

International standard	Corresponding British Standard
ISO 105-1978	BS 1006:1978 Methods of test for colour fastness of textiles and leather (Technically equivalent) BS 2782 Methods of testing plastics
ISO 293-1974	Method 901A:1977 Compression moulding test specimens of thermoplastic materials (Identical)
ISO 294-1975	Method 910A:1977 Injection moulding test specimens of thermoplastic materials (Identical)
ISO 295-1974	Method 902A:1977 Compression moulding test specimens of thermosetting materials (Identical)
ISO 877-1976	Method 540A:1977 Determination of resistance to change upon exposure under glass to daylight (Identical)
ISO 2557/1-1976	Method 940A:1981 Preparation of test specimens of amorphous thermoplastic moulding material with a defined level of shrinkage in the form of parallelepipedic bars by compression moulding and injection moulding (Identical)
ISO 2557/2-1979	Method 940B:1981 Preparation of test specimens of amorphous thermoplastic moulding material with a defined level of shrinkage in the form of rectangular plates by injection moulding (Identical)
ISO 4582-1978	Method 552A:1981 Determination of the change in colour upon exposure under glass, natural weathering or artificial light (Identical)
ISO 4607-1978	Method 550A:1981 Methods of exposure to natural weathering (Identical)

There are no corresponding British Standards for ISO 3167 and ISO 2818, referred to in 6.2. As these references constitute informative matter only the validity of this British Standard is not affected. A related standard to ISO 2818–1980 is BS 2782:Method 930A:1977 “Preparation of test specimens by machining”.

There is at present no corresponding British Standard for ISO 2579 but it is expected that it will be implemented within BS 2782 without deviation.

The technical committee has reviewed the draft provisions of ISO 3557 and ISO 3558, to which reference is made in clause 3, and has decided that they are acceptable for use in conjunction with this standard. A related standard to ISO 3558 is BS 2782:Method 530B:1976 “Determination of the colour of near-white or near-colourless materials”.

Additional information. It should be noted that the apparatus using fluorescent tube lamps described in Annex D is in use in the United Kingdom and offers an economic and adequate alternative to the other three forms of apparatus described.

Further information on the use of plastics in design engineering may be found in BS 4618 “Recommendations for the presentation of plastics design data” Section 4.3:1974 “Resistance to colour change produced by exposure to light”.

WARNING NOTE. This British Standard method, which is identical with ISO 4892, does not necessarily detail all precautions necessary to meet the requirements of the Health and Safety at Work etc. Act 1974. Attention should be paid to any appropriate safety precautions and the method should be operated only by trained personnel.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

The effects of light on the colour and other properties of plastics are of considerable technical and commercial importance. Methods of exposing plastics to natural light are dealt with in ISO 877 and ISO 4607. There is, also, a need to gain information more rapidly by accelerated procedures and for this purpose specific artificial light sources are used. However, experience has shown that many problems arise when trying to correlate the results obtained from testing using artificial light sources with those obtained in natural daylight (see Annex A).

For some specific applications it may be possible to use certain fluorescent lamps as light sources. However, there is at present insufficient information on the reliability and repeatability of the results from such exposures to warrant inclusion of this type of apparatus in this International Standard. Investigations into these matters are being undertaken and it is hoped that as a result, fluorescent lamp light sources may be incorporated in a future revision of this International Standard.

Information on fluorescent lamps and their possible use is given in Annex D, which may assist interested parties in making their own investigations into the use of such devices.

1 Scope

This International Standard specifies methods for exposing specimens to laboratory light sources in order to assess changes produced by such exposure. The following types of light source are included:

- a) xenon arc lamp;
- b) enclosed carbon arc lamp;
- c) open-flame carbon arc lamp.

Of the different light sources, the xenon arc is advantageous in that it can, when correctly filtered and maintained, yield a spectrum most closely approximating to that of daylight. The carbon arc sources yield light which is considerably different from daylight and their use is decreasing. However, they have been found useful for some specific purposes and are still in considerable use in some countries; for this reason they have been included in this International Standard.

This International Standard also specifies means of determining radiation dosage.

For the method of determination of changes in properties after exposure, reference is made to ISO 4582.

2 Field of application

Testing with laboratory light sources usually has one of the following purposes:

- a) to obtain results by accelerated testing under controlled, less variable conditions to indicate behaviour that would result from prolonged exposure to natural daylight;
- b) for control tests on a material of known light resistance to establish that the level of quality of different batches does not vary from a known acceptable control.

NOTE Guidance concerning the problems of correlation between the effects of exposure to artificial light sources and those obtained after exposure to natural light is given in Annex A.

For a), changes in the specimens are determined at each of a number of light exposure stages, to give a sufficiently full picture of the performance throughout exposure. This method is also used, with interpolation if necessary, to find the amount of exposure needed to produce a specified change in the material.

For b), a suitable exposure stage is selected in advance from a knowledge of the expected light resistance of the material, and the change in the specimens is evaluated at this stage only. Alternatively, the exposure stage may be determined at which a defined change in the properties of the exposed test specimens occurs.

3 References

- ISO 105, *Textiles — Tests for colour fastness.*
- ISO 293, *Plastics — Compression moulding test specimens of thermoplastic materials.*
- ISO 294, *Plastics — Injection moulding test specimens of thermoplastic materials.*
- ISO 295, *Plastics — Compression moulding test specimens of thermosetting materials.*
- ISO 877, *Plastics — Determination of resistance to change upon exposure under glass to daylight.*
- ISO 2557, *Plastics — Amorphous thermoplastic moulding materials — Preparation of test specimens with a defined level of shrinkage.*
- ISO 2579, *Plastics — Instrumental evaluation of colour difference¹⁾.*
- ISO 2818, *Plastics — Preparation of test specimens by machining.*
- ISO 3167, *Plastics — Preparation and use of multipurpose test specimens.*
- ISO 3557, *Plastics — Recommended practice for spectrophotometry and calculation of colour in CEI systems¹⁾.*

¹⁾ At present at the stage of draft.

ISO 3558, *Plastics — Assessment of the colour of near-white or near-colourless materials*²⁾.

ISO 4582, *Plastics — Determination of the changes of colour and variations in properties after exposure to daylight under glass, natural weathering or artificial light*.

ISO 4607, *Plastics — Determination of resistance to natural weathering*.

4 Principle

Specimens of the material to be tested are exposed to the light source together with means of assessing the light dosage. These may comprise one or more of the following:

4.1 Physical standards which change in colour or other well-defined properties upon exposure to light, the degree of change indicating the light dosage.

4.2 Instrumental means of measuring irradiance and/or integrating this to give the light dosage over a period of time.

5 Apparatus

5.1 Laboratory light sources

5.1.1 General

To improve the correlation with natural sunlight it is necessary that the spectrum of the light source be as near as possible to that of natural sunlight, particularly in the ultra-violet region, because some plastics are very sensitive to the spectral distribution of the radiation. However, the intensity of the radiation will generally be higher than that of natural sunlight because of the need to accelerate the degradation processes in laboratory tests even though correlation with the simulated exposure condition may be weakened (see Annex A).

Recommendations for the integrated irradiance and spectral distribution of simulated solar radiation for test purposes in the laboratory are given in CIE³⁾ publication No. 20 (TC 22) 1972. The recommendation for the integrated irradiance for testing the deterioration resistance of materials and equipment exposed to natural radiation is

$$1 \text{ kW/m}^2 (= 100 \text{ mW/cm}^2) \pm 10 \%$$

The spectral distribution is given in Table 2.1 of CIE publication No. 20 (TC 22) 1972 (reproduced herein as Annex C). Although this is the present standard, for various reasons it is not practicable to reproduce this radiation level exactly in either spectral distribution or intensity with presently available apparatus.

Three laboratory light sources in current use are included in this International Standard.

5.1.2 Xenon arc lamp

The xenon arc lamp emits radiation in a range which extends from below 270 nm in the ultra-violet through the visible spectrum and into the infra-red. For exposure tests, light from the lamp is filtered to reduce shorter wavelength emissions and also to remove as much of the infra-red as possible, so that radiation reaching specimens exposed to it has a spectral power distribution that closely matches sunlight. The facility may also be available to reduce shorter wavelength energy further so that an alternative spectrum, similar to that of solar radiation as received behind window glass, may be obtained. These two modes of operation are often available on the same equipment, using different filter systems.

The characteristics of xenon arcs and filters are subject to changes in use due to ageing, and they shall be replaced at appropriate intervals. Further, they are subject to changes due to the accumulation of dirt, and they shall be cleaned at appropriate intervals as agreed between the interested parties.

The irradiance at the test specimen face in the wavelength range 300 to 890 nm shall normally be $1\,000 \pm 200 \text{ W/m}^2$. If, exceptionally, other intensities are used, this shall be stated in the test report. Irradiance below 300 nm shall not exceed 1 W/m^2 . The irradiance shall not vary by more than $\pm 10 \%$ over the whole test specimen area.

5.1.3 Enclosed carbon arc lamp

The lamp comprises an arc formed between pure carbon rod electrodes, solid at one pole and cored at the other, and has automatic carbon feed.

NOTE The carbon rods in normal usage need changing about every 24 h, but rods of longer life which need changing after 48 h are now available and thus facilitate ease of running over week-ends and minimize the dark periods necessitated by the changing of carbons.

The arc is enclosed in a globe made of heat-resistant glass transmitting less than 1 % light at 275 nm and shorter wavelengths, and approximately 90 % from 370 nm throughout the visible spectrum.

The globe fits securely; it is clean and free from chips or cracks and it is so maintained at each change of electrodes. The characteristics of the glass filter are subject to changes in use due to ageing, and the globes shall be discarded at appropriate intervals as agreed between the interested parties and immediately when any noticeable discoloration or cloudiness (as compared with an unused globe) occurs.

²⁾ At present at the stage of draft.

³⁾ International Commission on Illumination.