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Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method

Plastiques — Détermination au moyen d'instruments de l'exposition énergétique lors d'essais d'exposition aux intempéries — Lignes directrices générales et méthode d'essai fondamentale

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

This document 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 9370:2009), which has been technically revised.

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

— the calibration procedure of selective (UV) radiometers is described more precisely;

— Annex B has been introduced to give more explanation of a possible spectral mismatch of selective filter radiometers (systematic error).

Introduction

Defining periods of natural weathering, accelerated natural weathering, artificial accelerated weathering or artificial accelerated irradiation exposure solely in terms of time ignores the effects caused by variation in the spectral irradiance of the light source and the effects of moisture and/or temperature differences between different exposure tests. Defining periods of natural weathering exposure in terms of total solar radiant exposure has been shown to be useful for comparing results for these exposures conducted at different times at the same location. However, it is also important to monitor solar ultraviolet radiant exposure for natural weathering exposures and the ultraviolet radiant exposure in artificial accelerated weathering or artificial accelerated irradiation exposures.

Two approaches to the measurement of ultraviolet radiation are commonly used. The first is to use a physical standard, i.e. to expose a reference material that shows a change in property in proportion to the dose of incident UV radiation. The preferred approach is to use a radiometer that responds to the ultraviolet. This document deals with this approach. It recommends important characteristics for the instruments used and provides guidance for the selection and use of these radiometers.

Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method

1 Scope

This document specifies methods for the instrumental measurement of irradiance on a planar surface. This includes not only natural solar radiation but also intensified natural solar radiation and radiation produced by laboratory light sources.

For measurement of solar radiation for natural weathering and accelerated natural weathering, instrumental techniques include the continuous measurement of total solar, solar ultraviolet and spectral solar (ultraviolet) irradiance and the accumulation, or integration, of instantaneous data to provide the radiant exposure.

For measurement of radiation in artificial accelerated weathering or artificial accelerated irradiation exposures, instrumental techniques include the continuous measurement of total or defined wavelength bands of ultraviolet radiation, visible spectral irradiance and/or ultraviolet spectral irradiance and the accumulation, or integration, of instantaneous data to provide the radiant exposure.

This document does not specify procedures using blue-wool standards, chemical actinometry or polymeric or other film dosimetry.

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 9059, *Solar energy — Calibration of field pyrheliometers by comparison to a reference pyrheliometer*

ISO 9060, *Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9846, *Solar energy — Calibration of a pyranometer using a pyrheliometer*

ISO 9847, *Solar energy — Calibration of field pyranometers by comparison to a reference pyranometer*

ASTM E816, *Standard Test Method for Calibration of Pyrheliometers by Comparison to Reference Pyrheliometers*

ASTM E824, *Standard Test Method for Transfer of Calibration From Reference to Field Radiometers*

ASTM G90, *Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight*

ASTM G130, *Standard Test Method for Calibration of Narrow- and Broad-Band Ultraviolet Radiometers Using a Spectroradiometer*

ASTM G138, *Standard Test Method for Calibration of a Spectroradiometer Using a Standard Source of Irradiance*

ASTM G183, *Standard Practice for Field Use of Pyranometers, Pyrheliometers and UV Radiometers*

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:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
artificial accelerated weathering
exposure of a material in a laboratory weathering device to conditions which may be cyclic and intensified over those encountered in outdoor or in-service exposure

Note 1 to entry: This involves a laboratory radiation source, heat and moisture (in the form of relative humidity and/or water spray, condensation or immersion) in an attempt to produce more rapidly the same changes that occur in long-term outdoor exposure.

Note 2 to entry: The device may include means for control and/or monitoring the light source and other weathering variables. It may also include exposure to special conditions, such as acid spray to simulate the effect of industrial gases.

3.2
artificial accelerated irradiation
exposure of a material to a laboratory radiation source meant to simulate window-glass-filtered solar radiation or radiation from interior lighting sources and where specimens can be subjected to relatively small changes in temperature and relative humidity in an attempt to produce more rapidly the same changes that occur when the material is used in an indoor environment

3.3
blocking
ability of a filter to reject or not transmit radiation outside the intended passband, usually expressed as a fraction or percentage of the incident radiation

3.4
broad-band
characteristic of filters and radiometers for which the *full width at half maximum* (3.15) is between 20 nm and 70 nm

Note 1 to entry: It typically describes a filter radiometer measuring in the 300 nm to 400 nm range.

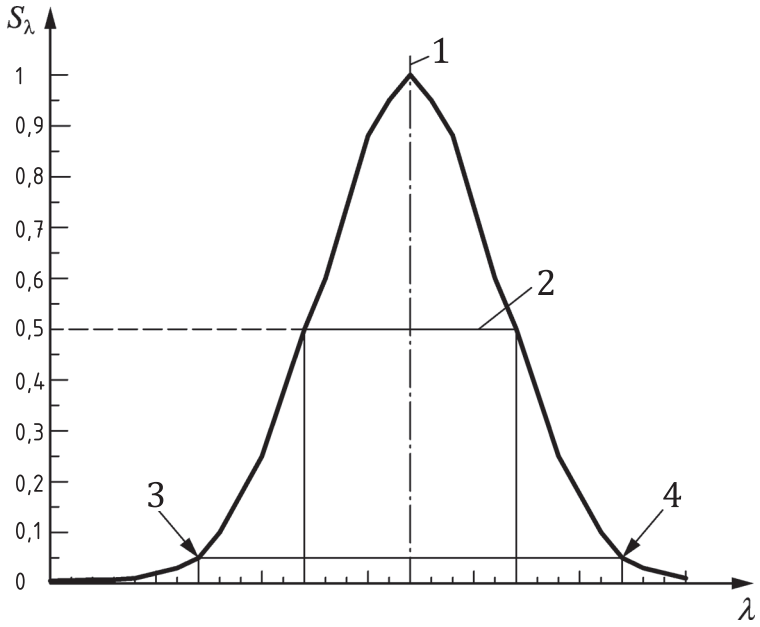
3.5
centre wavelength
CW
wavelength located at the midpoint of the *full width at half maximum* (3.15) interval

Note 1 to entry: See Figure 1.

3.6
cosine receptor
radiation-transferring device that samples radiant flux in accordance with the cosine of the incident angle and that collects all radiation incident in 2π steradians (i.e. in a hemisphere) using, for example, an integrating sphere or a plane diffuser

3.7
cut-off wavelength
wavelength at which the transmittance has decreased to 5 % of the peak transmittance when going from the peak transmittance towards the long-wavelength blocking region

Note 1 to entry: See point 4 in Figure 1.



Key

λ wavelength in nm
S_λ normalized spectral response
1 centre wavelength (CW)
2 full width at half maximum (FWHM)
3 cut-on wavelength
4 cut-off wavelength

Figure 1 — UV radiometer spectral response

3.8
cut-on wavelength
wavelength at which the transmittance has increased to 5 % of peak transmittance when going from the short-wavelength blocking region towards the transmitting region

Note 1 to entry: See point 3 in Figure 1.

3.9
detector
photoreceptor, forming part of a radiometer, that converts incident radiation into an electrical signal for the purpose of determining the irradiance of a surface

3.10
diffuse solar radiation
total of the sky- and (if within the field of view) ground-reflected radiation within the 2π steradian field of view of a plane surface, excluding the radiation from within the 5° to 6° solid angle centred on the sun's disc

Note 1 to entry: See 3.11.

3.11
direct radiation
direct solar radiation
direct beam radiation
solar irradiance included within a restricted solid angle (typically 5° to 6°) centred on the sun's disc

Note 1 to entry: If the direct normal solar radiation is known, the direct radiation on a tilted plane can be calculated by multiplying the direct normal solar radiation by the cosine of the angle defined by the normal to the plane and a line from the foot of the normal to the centre of the sun's disc.

3.12
direct normal solar radiation
direct solar radiation incident on a plane normal (perpendicular) to the solar beam

Note 1 to entry: Direct normal solar radiation is measured with a pyrheliometer.

3.13
drift
rate of change of the responsivity of a measurement instrument over time that indicates the time-based stability of the instrument

3.14
field of view
full angle of the cone that is defined by the centre of the receiver surface and the border of the limiting aperture

3.15
full width at half maximum
FWHM
⟨in a passband⟩ interval between the wavelengths at which transmittance is 50 % of peak transmittance, frequently referred to as the "bandwidth"

3.16
hemispherical solar radiation
⟨on a tilted plane⟩ total of the direct solar radiation incident on a plane surface plus all sky- and ground-reflected radiation within the 2π steradian field of view of the surface

Note 1 to entry: If the tilt of the plane surface is zero degrees (i.e. it is horizontal), then the hemispherical solar radiation is often referred to as global solar radiation or global horizontal radiation.

3.17
interference filter
filter that defines the spectral composition of the transmitted radiation by the effects of interference

Note 1 to entry: Most interference filters consist of thin layers of metals and dielectrics, resulting in high transmittance over selected spectral bands.

3.18
irradiance
E
radiant flux per unit area, measured in watts per square metre ($W \cdot m^{-2}$), incident on a surface

3.19
global solar irradiance
solar radiant flux, both direct and diffuse, received by a horizontal plane of unit area from a solid angle of 2π steradians

Note 1 to entry: It is measured in watts per square metre ($W \cdot m^{-2}$).

