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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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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 9370 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance*.

This second edition cancels and replaces the first edition (ISO 9370:1997), which has been technically revised.

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 International Standard 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

1.1 This International Standard 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.

1.2 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.

1.3 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.

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

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 877-3, *Plastics — Methods of exposure to solar radiation — Part 3: Intensified weathering using concentrated solar radiation*

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 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*

Guide to meteorological instruments and methods of observation, WMO Publication No. 8, World Meteorological Organization, Geneva

3 Terms and definitions

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

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 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 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

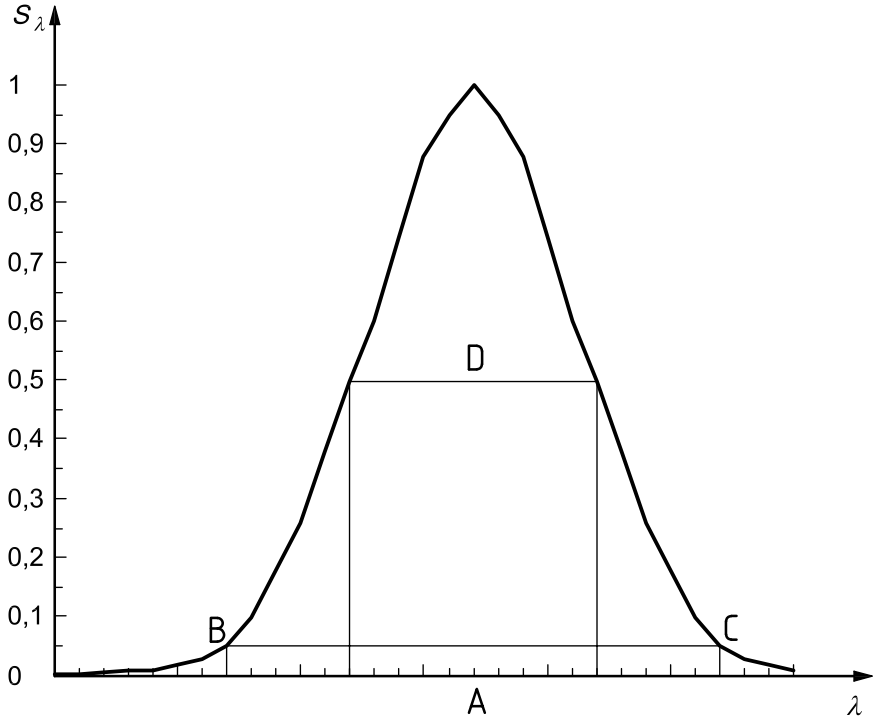
3.3
blocking
ability of a filter to reject or not transmit radiation outside the intended passband, usually expressed as a fraction or percentage of the incident radiation

3.4
broad-band
relative term, generally applied to filters and to radiometers for which the FWHM (full width at half maximum) is between 20 nm and 70 nm, which 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 FWHM (full width at half maximum) interval (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 (point C in Figure 1)



Key

λ	wavelength in nm
S_λ	normalized spectral response
A	centre wavelength (CW)
B	cut-on wavelength
C	cut-off wavelength
D	FWHM (full width at half maximum)

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 (point B 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 See 3.11, direct radiation.

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 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 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 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 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, measured in watts per square metre ($W \cdot m^{-2}$)

3.20
spectral irradiance
E_λ
irradiance per wavelength interval, typically reported in watts per square metre per nanometre ($W \cdot m^{-2} \cdot nm^{-1}$)

3.21
long-pass filter
filter that transmits wavelengths longer than the cut-on wavelength while rejecting shorter wavelengths, and characterized by a sharp transition from minimum to maximum transmittance

3.22
narrow-band
relative term which applies to interference filters with an FWHM (full width at half maximum) of no more than 20 nm

NOTE In narrow-band filters of the same type, the reproducibility of the centre wavelength and the FWHM will normally be within ± 2 nm.

3.23
passband
⟨in a bandpass filter⟩ wavelength interval between cut-on and cut-off (see Figure 1)

3.24
peak wavelength
wavelength at maximum transmittance

NOTE The peak wavelength is not necessarily the same as the centre wavelength (see Figure 1).

3.25
pyranometer
radiometer used to measure global solar irradiance (or, if inclined, hemispherical solar irradiance)

3.26
pyrheliometer
radiometer used to measure the direct normal solar radiation

3.27
radiant exposure
H
time integral of irradiance, measured in joules per square metre ($J \cdot m^{-2}$)

3.28
radiometer
instrument for measuring electromagnetic radiation, consisting of a detector, any necessary filters and diffusers, and a signal-processing device

3.29
reference radiometer
instrument used to realize a standard measurement value with respect to a recognized radiation scale (e.g. the World Radiation Reference spectral irradiance scale) with a stated path of traceability to recognized standards and a stated measurement uncertainty

NOTE A reference radiometer is used only to calibrate other radiometers by comparison, substitution or another direct relationship.

3.30
field radiometer
instrument deployed in the field or in a laboratory accelerated-weathering device used for the routine measurement of radiation, with a calibration traceable to a recognized standard scale, through transfer of the scale by comparison, substitution, or other direct relationship with a reference radiometer

3.31
short-pass filter
filter that transmits wavelengths shorter than the cut-off wavelength while rejecting longer wavelengths, and characterized by a sharp transition from maximum to minimum transmittance

3.32
spectroradiometer
instrument for measuring spectral irradiance in narrow-wavelength intervals over a given spectral region as a function of wavelength