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Optics and photonics — Measurement of reflectance of plane surfaces and transmittance of plane parallel elements

Optique et photonique — Mesurage du facteur de réflexion des surfaces planes et du facteur de transmission des éléments à plan parallèle

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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.

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 of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition ISO 15368:2001 which has been technically revised. The main changes compared to the previous edition are as follows:

— Throughout the document, descriptions of the use of Fourier transform spectrometer instruments have been expanded and added where appropriate to an equivalent level as those of monochromator instruments.

— Throughout the document, the term “light” has been replaced with “optical radiation” to reflect that this standard’s spectral range extends beyond the visible.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Measurements of reflectance and transmittance using spectrophotometers are the most fundamental methods for the characterization of optical components. Since the spectrophotometric methods are basic and normal, they are extensively used and provide measurement data over a wide range of wavelengths.

This document describes the measurement of reflectance and transmittance using spectrophotometers, which provides data with high reproducibility and repeatability.

Optics and photonics — Measurement of reflectance of plane surfaces and transmittance of plane parallel elements

1 Scope

This document provides rules for the measurement of the spectral reflectance of plane surfaces and the spectral transmittance of plane parallel elements using spectrophotometers.

This document only applies to measurements of the regular transmittance and the regular reflectance; it does not apply to those of the diffuse transmittance and the diffuse reflectance.

This document is applicable to test samples, which are coated or uncoated optical components without optical power.

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 9211-1, *Optics and photonics — Optical coatings — Part 1: Vocabulary*

ISO 10110-8, *Optics and photonics — Preparation of drawings for optical elements and systems — Part 8: Surface texture*

ISO 80000-7, *Quantities and units — Part 7: Light and radiation*

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 60050-845, *International Electrotechnical Vocabulary — Chapter 845: Lighting*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9211-1, ISO 80000-7, IEC 60050-845 and ISO/IEC Guide 98-3, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

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

3.1
transmittance
<for incident radiation of a given spectral composition, polarization and geometrical distribution> ratio of the transmitted radiant or luminous flux to the incident flux in the given conditions

[SOURCE: IEC 60050-845:1987, 845-04-59]

3.2
regular transmittance
ratio of the regularly transmitted part of the (whole) transmitted flux, to the incident flux

[SOURCE: IEC 60050-845:1987, 845-04-61]

3.3
diffuse transmittance
ratio of the diffusely transmitted part of the (whole) transmitted flux, to the incident flux

Note 1 to entry: $\tau = \tau_r + \tau_d$ (see also Clause 4).

Note 2 to entry: The results of the measurements of τ_r and τ_d depend on the instruments and the measuring techniques used.

[SOURCE: IEC 60050-845:1987, 845-04-63]

3.4
internal transmittance
ratio of the radiant or luminous flux reaching the internal exit surface of the layer to the flux that enters into the layer after crossing the entry surface

3.5
reflectance
<for incident radiation of a given spectral composition, polarization and geometrical distribution> ratio of the reflected radiant or luminous flux to the incident flux under the given conditions

[SOURCE: IEC 60050-845:1987, 845-04-58]

3.6
regular reflectance
ratio of the regularly reflected part of the (whole) reflected flux, to the incident flux

[SOURCE: IEC 60050-845:1987, 845-04-60]

3.7
diffuse reflectance
ratio of the diffusely reflected part of the (whole) reflected flux, to the incident flux

Note 1 to entry: $\rho = \rho_r + \rho_d$ (see also Clause 4).

Note 2 to entry: The results of the measurements of ρ_r and ρ_d depend on the instruments and the measuring techniques used.

[SOURCE: IEC 60050-845:1987, 845-04-62]

3.8
relative reflectance
ratio of the reflected flux from a sample to that from a reference

4 Symbols and units

For the purposes of this document, the following symbols and units apply.

λ wavelength, expressed in nanometres

p, s state of polarization

τ transmittance

τ_r regular transmittance

τ_d	diffuse transmittance
τ_i	internal transmittance
ρ	reflectance
ρ_r	regular reflectance
ρ_d	diffuse reflectance
$\rho_{r,rel}$	relative regular reflectance

NOTE Wherever the Greek letters, ρ and τ, are mistakable, T and R can be used.

5 Test sample

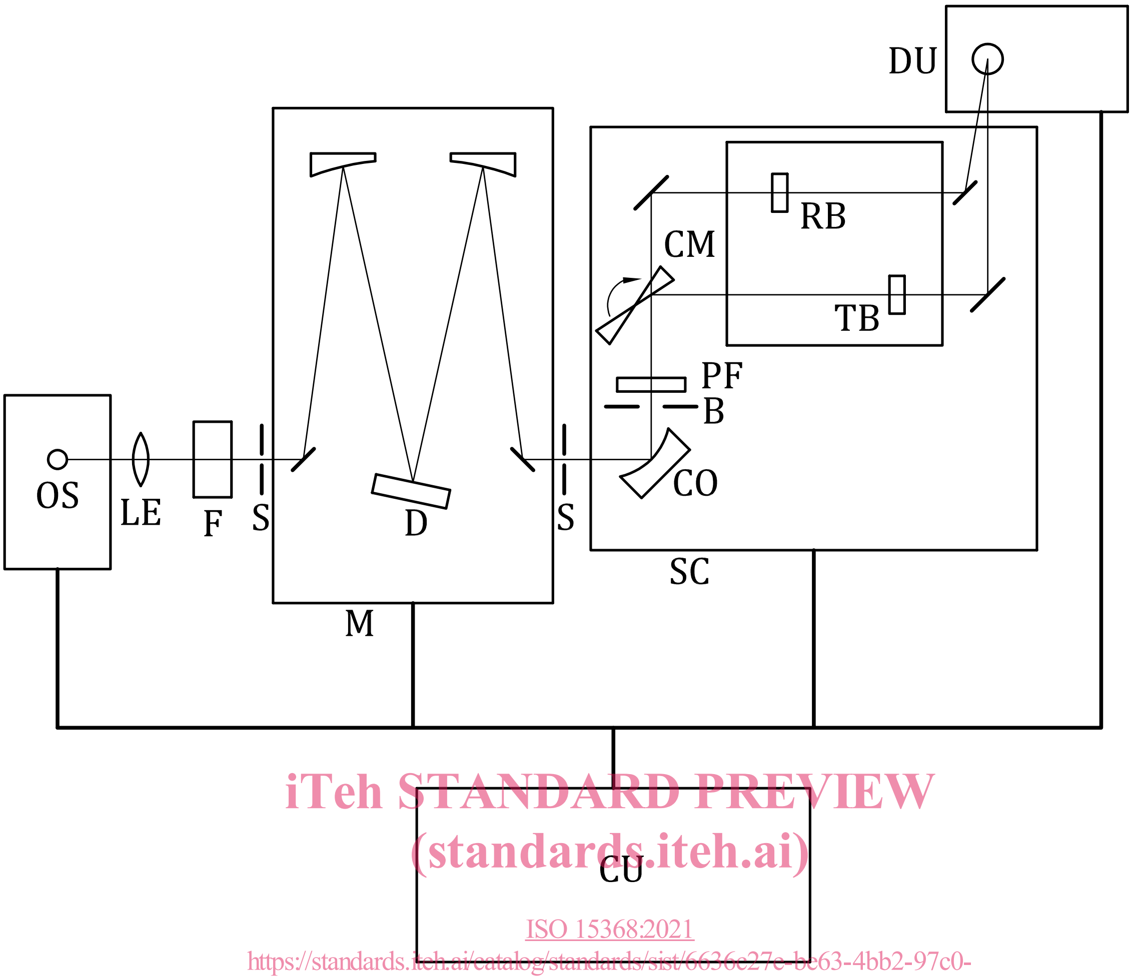
The storage, cleaning and preparation of a test sample shall be carried out in accordance with the instructions of the manufacturer on the test sample for normal use.

The wavelength, angle of incidence and state of polarization shall correspond to those specified by the manufacturer for the use of the test sample.

6 Measuring apparatus

For the measurements specified in this document, a spectrophotometer is required. Figure 1 shows an example of a double beam, dispersive type spectrophotometer. Figure 2 shows an example of a single beam, interferometer type Fourier-transform spectrophotometer (FTS). Both types consist of an optical radiation source, a spectral unit, a sample compartment, a detector unit and a control unit.

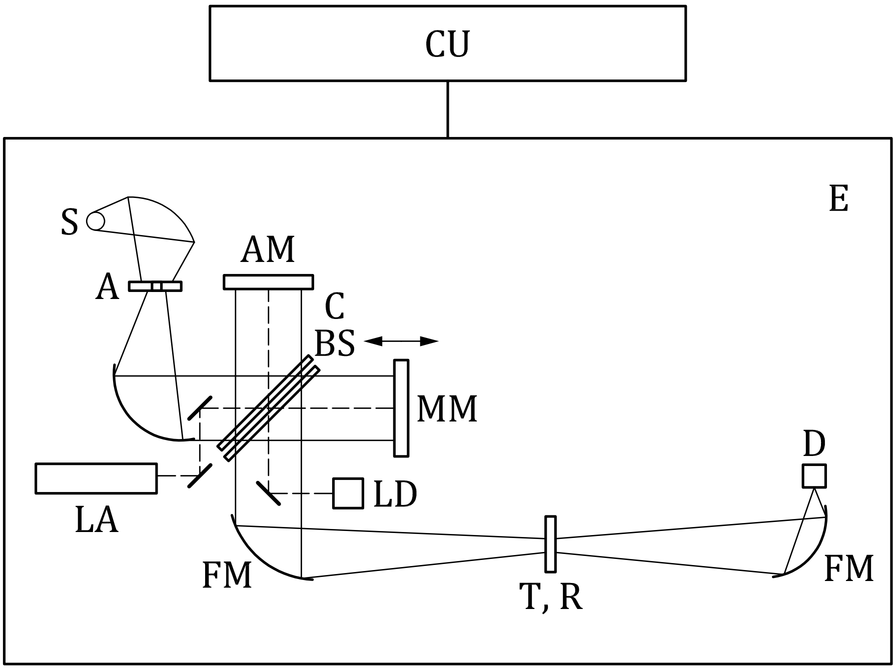
Details of the apparatus are described in Annex A.



Key

OS optical radiation source
LE lens
F filter box
S slit
D dispersive element
M monochromator
SC sample compartment
CO collecting optics
B baffle
PF polarization filter
CM chopper mirror
TB test beam and test sample
RB reference beam and reference sample
DU detector unit
CU control unit

Figure 1 — Typical arrangement of a dispersive spectrophotometer



Key

E enclosure

S source

A aperture

BS beam splitter

C compensator plate

AM alignment mirror

FM focusing mirror

MM moving mirror

T, R sample or reference for transmittance and reflectance

LA laser

LD laser detector

CU control unit

D detector unit

Figure 2 — Typical arrangement of a Fourier-transform spectrophotometer

7 Test conditions

7.1 Dispersive type spectrophotometer

7.1.1 General

The optical radiation source, the divergence of the beam, the beam diameter on the sample, the wavelength, spectral resolution, the stepping interval, the incident angle, the detector and any required numerical correction shall be selected and documented.

7.1.2 Optical radiation source

The temporal variation of the intensity of the optical radiation source shall be measured and documented. The state of polarization (*p* or *s*) of the beam shall be selected and documented.

The state of polarization of the radiation reaching the detector can be affected by reflection on components in the reference/sample paths. It is suggested to tilt a transmitting sample by equal amounts in orthogonal directions to check for polarization effects. The beam diameter on the sample shall be larger than 1 mm. On the surface of the sample, the beam profile shall be smooth so that the local peak power density does not exceed the average power density by a factor of greater than or equal to two. The beam diameter and f–number or numerical aperture (see also 9.11) shall be documented.