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Optics and photonics — Test method for refractive index of optical glasses —

Part 1: Minimum deviation method

*Optique et photonique — Méthode d'essai pour déterminer l'indice de
réfraction des verres optiques —*

Partie 1: Méthode de la déviation minimale

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Foreword

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This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 3, *Optical materials and components*.

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Introduction

The refractive index of optical glasses has been measured by various methods, but an International Standard for the measurement has not existed so far. The refractive index of optical glasses is the most important characteristic for the optical elements to be manufactured from them. This document defines a suitable method for measuring the refractive index of optical glasses accurately and also helps to improve communication between raw optical glass suppliers and optical element manufacturers.

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Optics and photonics — Test method for refractive index of optical glasses —

Part 1: Minimum deviation method

1 Scope

This document specifies the measuring method for the refractive index of optical glasses with the accuracy within 1×10^{-5} used in the spectral range from 365 nm to 2 400 nm.

Additional information on how to apply the refractive index in the dispersion and the various dispersion formulas of optical glasses is given in [Annex A](#) and [Annex B](#).

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.

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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/>

4 Principle

As shown in [Figure 1](#), when the monochromatic light beam is refracted by the specimen prism at the angle of minimum deviation, the relative refractive index of the specimen prism to the air at the wavelength of the monochromatic light beam is described by the following [Formula \(1\)](#):

$$n_{\text{rel}} = \frac{\sin \frac{\alpha + \delta_{\text{min}}}{2}}{\sin \frac{\alpha}{2}} \quad (1)$$

where

- n_{rel} is the relative refractive index ($n_{\text{rel}} = n_{\text{abs}}/n_{\text{air}}$);
- n_{abs} is the absolute refractive index of the specimen prism;
- n_{air} is the refractive index of air;
- α is the apex angle;
- δ_{min} is the angle of minimum deviation.

As shown in [Figure 1](#), light enters the plane AB of the specimen prism at an angle of incidence (θ) and exits from the plane AC at an exit angle (θ'). The incident and the exiting light ray form the deviation angle (δ). With the deviation angle minimized the incident and the exiting angles are equal. The smallest angle of deviation is called the angle of minimum deviation. The angle of incidence equals to the angle of emission when the angle of deviation is minimized. The angle of minimum deviation (δ_{min}) and the apex angle (α) of the specimen prism are measured, and the refractive index is calculated using those angles. Formulae for the calculation of principal dispersion, Abbe number, partial dispersion, and relative partial dispersion are given in [Annex A](#). Formulae for calculating calculating the refractive index at other wavelengths than the measured ones dispersion formulas are given in [Annex B](#). The correction of the refractive index of optical glasses for temperature, humidity, and atmospheric pressure of optical glasses are given in [Annex C](#).

NOTE When measuring the refractive index with this method, it is necessary to consider temperature, pressure, humidity and measurement error. Expressions for the relations of these errors are described in ISO 17328. The dependence of the refractive index of air on temperature and pressure can be found in ISO 12123:2018, A.3.

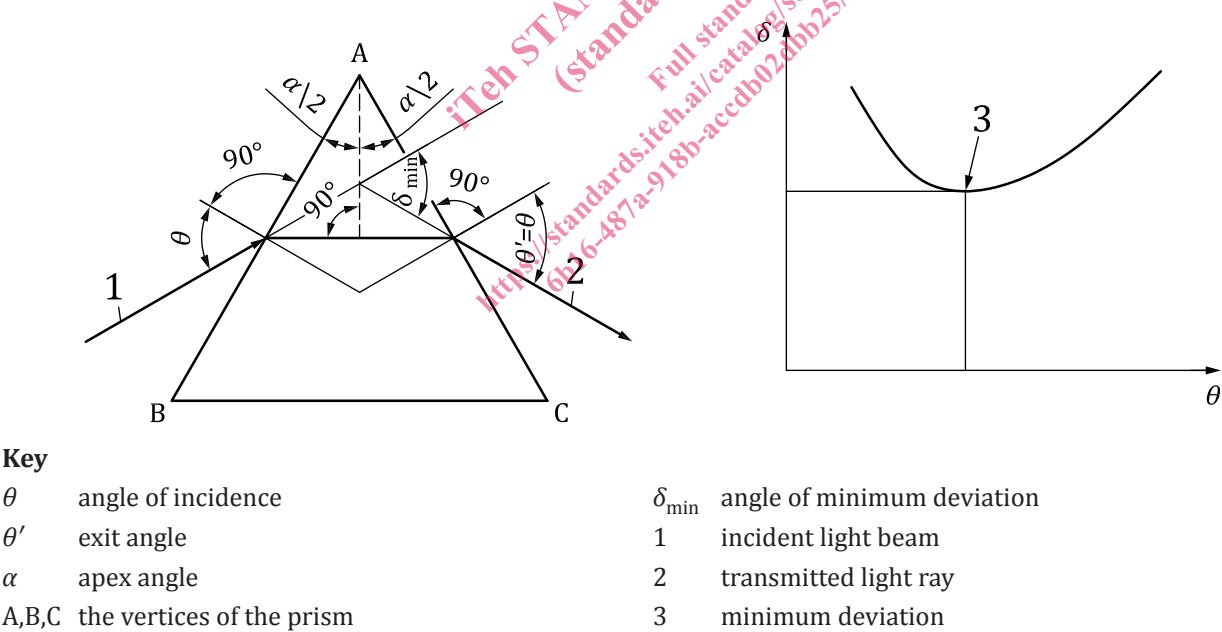
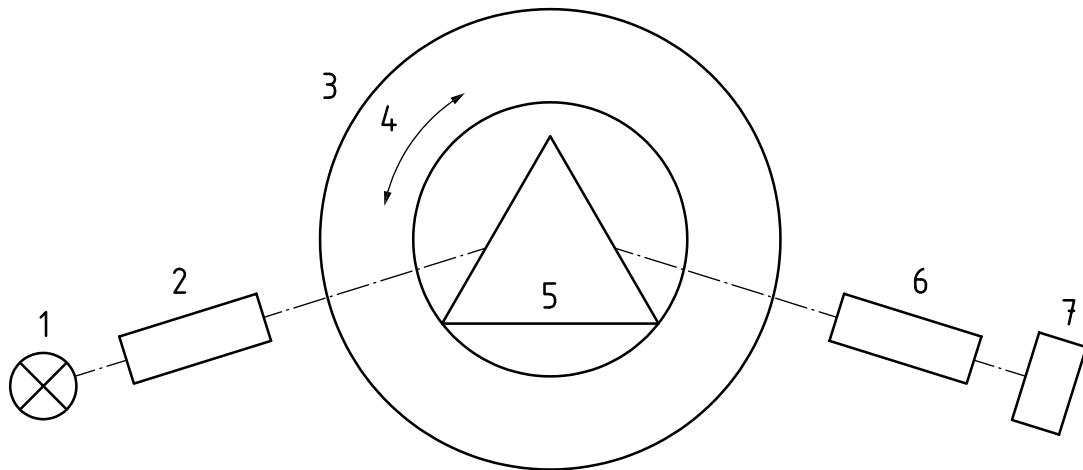


Figure 1 — Principle of minimum deviation method

5 Measuring apparatus

5.1 General

The measuring apparatus is shown in [Figure 2](#).



Key

- | | | | |
|---|--|---|---------------------------------------|
| 1 | light source | 4 | rotating stage coupled with prism (5) |
| 2 | collimator | 5 | specimen prism |
| 3 | goniometer coupled with telescope (6) and detector (7) | 6 | telescope |
| | | 7 | detector |

Figure 2 — Schematic of minimum deviation method

5.2 Goniometer

The goniometer shall provide the capability of the angle reading within ± 1 arc sec.

5.3 Light source

The light sources should be used lamps of mercury and hydrogen, helium, rubidium, caesium, cadmium, also He-Ne laser and Nd:YAG laser defined in ISO 7944. The wavelengths with the spectral lines are shown in [Table 1](#).

The light sources and the wavelength not defined in [Table 1](#) are also applicable for measurement, but the spectral bandwidth of light source and the accuracy/certainty of emission line (for example D line (589,3 nm)) should be checked before use.

Table 1 — Wavelength and spectral line of light source

Wavelength/nm	Spectral line	Light source
365,01	i	Mercury lamp
404,66	h	Mercury lamp
435,83	g	Mercury lamp
479,99	F'	Cadmium lamp
486,13	F	Hydrogen lamp
543,5	—	He-Ne laser
546,07	e	Mercury lamp
587,56	d	Helium lamp
632,8	—	He-Ne laser
643,85	C'	Cadmium lamp
656,27	C	Hydrogen lamp
706,52	r	Helium lamp

Table 1 (continued)

Wavelength/nm	Spectral line	Light source
780,00	—	Rubidium lamp
852,11	s	Cesium lamp
1 013,98	t	Mercury lamp
1 064,1	—	Nd:YAG laser
1 128,7	—	Mercury lamp
1 395,1	—	Mercury lamp
1 529,6	—	Mercury lamp
1 813,1	—	Mercury lamp
1 970,1	—	Mercury lamp
2 325,4	—	Mercury lamp

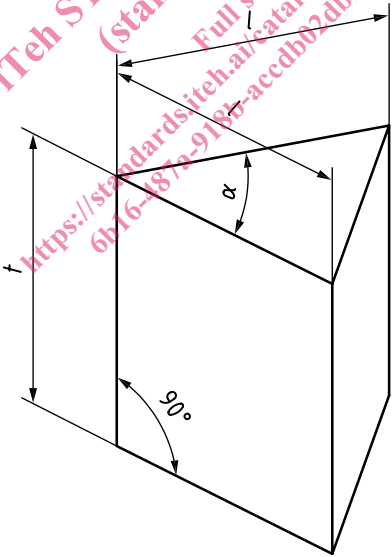
5.4 Detector

A general-type detector which is capable of detecting each wavelength or easily exchangeable for different spectral ranges should be used.

6 Specimen prism

6.1 General

An example of the shape of specimen prism is shown in Figure 3.



- Key
- l length
 - t thickness
 - α apex angle

Figure 3 — Shape of the specimen prism