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Optics and photonics — Spectral bands

Optique et photonique — Bandes spectrales

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Foreword

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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 20473 was prepared by Technical Committee ISO/TC 172, *Optics and photonics*.

Introduction

This International Standard is intended to support the delimitation, designation and description of the spectral wavelength regions of optical radiation for applications in the field of optics and photonics.

Optics and photonics — Spectral bands

1 Scope

This International Standard specifies the division of optical radiation into spectral bands for optics and photonics. It does not apply to lighting or telecommunication applications or to protection against hazards from optical radiation in occupational areas.

2 Definitions of spectral bands

The division of the optical radiation in spectral bands is given in Table 1.

The spectral bands are specified by the given wavelength limits. The band limits are included in both adjacent bands. The relation of frequency, wave number and photon energy to the wavelength holds strictly, only for vacuum; if applicable, the refractive index of the medium of propagation shall be taken into account.

As given in Table 1, the usage of the term “light” is restricted to designate “visible radiation”, i.e. the wavelength range from 380 nm to 780 nm and should not be used for optical radiation outside the visible range.

Table 1 — Spectral bands for optics and photonics

Designation of the radiation		Short designation			Spectral bands[a] Wavelength λ nm	Frequency ν THz	Wavenumber σ cm^{-1}	Photon energy Q_e eV
Ultraviolet radiation	extreme UV	UV		EUV	1 to 100	3×10^5 to 3 000	10^7 to 10^5	1 240 to 12,4
	vacuum UV		UV-C	VUV	100 to 190	3 000 to 1 580	10^5 to 53 000	12,4 to 6,5
	deep UV			DUV	190 to 280	1 580 to 1 070	53 000 to 36 000	6,5 to 4,4
	mid UV		UV-B		280 to 315	1 070 to 950	36 000 to 32 000	4,4 to 3,9
	near UV		UV-A[b]		315 to 380	950 to 790	32 000 to 26 000	3,9 to 3,3
Visible radiation, light		VIS			380 to 780	790 to 385	26 000 to 13 000	3,3 to 1,6
Infrared radiation	near IR	IR	IR-A	NIR	780 to 1400	385 to 215	13 000 to 7 000	1,6 to 0,9
			IR-B		1 400 to 3 000	215 to 100	7 000 to 3 300	0,9 to 0,4
	mid IR		IR-C	MIR	3 000 to 50 000	100 to 6	3 300 to 200	0,4 to 0,025
	far IR			FIR	50 000 to 10^6	6 to 0,3	200 to 10	0,025 to 0,001

[a] The wavelength values are valid for delimitation of the spectral bands. The values for frequencies, wave numbers and photon energies are approximate values given for convenience.

[b] For other fields of application, which are excluded from the scope of this International Standard, there may be different definitions. For example, IEC 60050-845:1987, identical with CIE Publication No 17.4, for its purpose, defines the upper limit of the UV-A band as 400 nm (see also Annex A).

Annex A
(informative)

Reasons behind the choice of 380 nm for the upper limit of UV-A

A.1 Qualitative comment

In the 1930s, the CIE (Commission internationale de l'éclairage) set the limits for UV-A as 315 nm to 400 nm. The CIE limits are based on the bio-actinic effects of radiation and they overlap with their limits for visible radiation, for which the *International Lighting Vocabulary* (CIE Publication No. 17.4, identical with publication IEC 60050-845:1987) term 845-01-03 states: "the lower limit is generally taken between 360 nm and 400 nm", the variation depending "upon the amount of radiant power reaching the retina and the responsivity of the observer".

While the CIE definition generally takes precedence, for purposes of applications, differing definitions may be more appropriate.

Hence, for the purposes of this International Standard for application in the field of optics and photonics, it was felt that a fixed limit should be set between UV-A and the visible region, and the chosen value of 380 nm falls in the middle of the CIE range for the lower limit for visible radiation.

Moreover, this limit of 380 nm is in line with the upper limit for UV-A used in both ophthalmic optics and general-wear sunglasses, which have taken the waveband for UV-A as 315 nm to 380 nm for many years.

A.2 Ophthalmic optics and general-wear sunglasses

Most resin ophthalmic spectacle lenses, even when untinted, have good absorption in the 315 nm to 380 nm waveband, or can be treated to have good absorption without becoming coloured. Some resin materials cannot be treated to absorb the 380 nm to 400 nm waveband, whilst others which can be so treated begin to show a faint yellow discolouration. This can be masked by adding very small amounts of a blue dye, but this then gives a reduction in the luminous transmittance of the lens.

Concern has been raised that the wearer of a pair of spectacles or sunglasses that absorb well up to 380 nm, but poorly between 380 nm and 400 nm, may be at risk of damage to ocular health.

For the unprotected eye, two factors influence the effects of UV radiation: firstly, the intensity of solar radiation rises rapidly from the UV-B region to the infrared region; secondly, the bio-actinic effect or the ability for the radiation to cause damage drops rapidly. The product of the solar spectral irradiance and the relative spectral effectiveness function is the weighting function for a calculation of the effect of the solar radiation to the eye (see ISO 13666).

When calculating the effects of the solar UV radiation for the protected or corrected eye, the sunglass or spectacle lens transmittance is multiplied by the weighting function as given in Annex A of ISO 13666:1998. Because of the low value of the weighting function towards the longer wavelength end of the UV-A spectrum, classing the incremental waveband from 380 nm to 400 nm as UV rather than visible spectrum has very little effect on eye protection for the normal wearer.

