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Optics and photonics — Diffractive optics — Vocabulary

Optique et photonique — Optique diffractive — Vocabulaire

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

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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).

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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.

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This second edition cancels and replaces the first edition (ISO 15902:2004), of which it constitutes a minor revision. It also incorporates the Technical Corrigendum ISO 15902:2004/Cor 1:2005.

The changes compared to the previous edition are as follows:

- in [3.3.3.4](#), an explanation on the factor has been added in a note to entry;
- in [3.4.3.4](#), the sign has been corrected;
- other editorial changes have been made.

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

The term diffractive optical element is used for those optical elements which convert an input wavefront to a predetermined output wavefront (or wavefronts) in free space by means of the phenomenon of diffraction. There has been a rapid increase in the use of diffractive optical elements, especially in the field of optical data storage, and they are essential components in optical and electro-optical systems. They are used in a wide variety of applications.

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Optics and photonics — Diffractive optics — Vocabulary

1 Scope

This document defines the basic terms for diffractive optical elements for free space propagation. The purpose of this document is to provide an agreed-upon common terminology that reduces ambiguity and misunderstanding and thereby aid in the development of the field of diffractive optics.

2 Normative references

There are no normative references in this document.

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:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>
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3.1 Diffractive optics technologies

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diffractive optics <https://standards.iteh.ai/catalog/standards/sist/f4af654a-4e3e-461f-a2c9-15c645e6cc9/iso-15902-2019>
optical technology based on the phenomenon of the diffraction of optical radiation

3.1.2

binary optics

diffractive optics technology whose optical components have a quantized surface structure in height

Note 1 to entry: The word binary originally means a two-step structure in cross section, however, a staircase structure in cross section is usually referred to as binary as well, regardless of the number of the steps. This incorrect wording originates from the fact that these structures are fabricated using a mask lithography technique.

Note 2 to entry: See [3.3.2.8](#) and [3.3.2.9](#).

3.1.3

holographic optics

diffractive optics technology that uses holograms as optical elements for transforming an incident wavefront into a specific wavefront or wavefronts

3.2 Diffractive optical elements and their types

3.2.1

diffractive optical element

DOE

optical element for which the phenomenon of the diffraction of optical radiation is the operating principle, usually characterized in terms of its periodic spatial structure

3.2.2

amplitude diffractive optical element

optical element which utilizes the diffraction created by its periodic spatial amplitude modulation

3.2.3

phase diffractive optical element

optical element which utilizes the diffraction created by its periodic spatial phase modulation

3.2.4

transmission diffractive optical element

diffractive optical element that operates with transmitted optical radiation

3.2.5

reflection diffractive optical element

diffractive optical element that operates with reflected optical radiation

3.2.6

active diffractive optical element

diffractive optical element whose diffraction characteristics can be dynamically changed

3.2.7

holographic optical element

HOE

diffractive optical element fabricated with an interferometric method

3.2.8

computer-generated diffractive optical element

computer-generated hologram (CGH)

diffractive optical element which is computer-designed and fabricated under computer control

Note 1 to entry: A computer-generated diffractive optical element is generally fabricated using a mechanical method or by lithography, using optical radiation waves (including laser beams), electron beams or ion beams, and is often referred to as a "computer-generated hologram (CGH)".

3.2.9

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binary optical element <https://standards.iteh.ai/catalog/standards/sist/f4af654a-4e3e-461f-a2c9-15c645e6cc9/iso-15902-2019>

BOE

phase-diffractive optical element having a binary-level or quantized multi-level surface-relief structure

Note 1 to entry: See Note 1 to entry in [3.1.2](#).

3.3 Structure of diffractive optical elements

3.3.1 General structure

3.3.1.1

substrate for diffractive optical elements

basic body of the diffractive optical element

Note 1 to entry: It may support the element's periodic structure on its surface, or it may contain that periodic structure within itself.

3.3.1.2

grating

periodic spatial structure for optical use

3.3.2 Phase structure

3.3.2.1

phase profile

phase distribution of a diffractive optical element, which is added to incident optical radiation

3.3.2.2**surface relief diffractive optical element**

optical element whose diffractive property is created by a periodic relief pattern deposited on or corrugated in the substrate

3.3.2.3**Q-factor**

Q-value

for a periodic structure with a sinusoidal refractive-index profile, this is given by

$$Q = \frac{2\pi\lambda T}{n_{av} A^2}$$

Note 1 to entry: The value is used to categorize gratings as either thick or thin. It should be noted that it is defined only for sinusoidal refractive index profile.

3.3.2.4**thin diffractive optical element**

diffractive optical element which produces Raman-Nath diffraction

Note 1 to entry: For a diffractive optical element with a sinusoidal refractive index profile, it is characterized by $Q < 1$.

3.3.2.5**thick diffractive optical element**

diffractive optical element which produces Bragg diffraction

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Note 1 to entry: For a diffractive optical element with a sinusoidal refractive index profile, it is characterized by $Q \gg 1$.

3.3.2.6

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volume phase diffractive optical element

thick diffractive optical element whose diffraction is created by a three-dimensional periodic refractive index distribution within the substrate

3.3.2.7**phase step**

stair step

step in binary phase structure

3.3.2.8**binary phase structure**

discrete phase structure that may have either simple binary or quantized phase steps

Note 1 to entry: See Notes to entry to [3.1.2](#) and [3.3.2.9](#).

3.3.2.9**multi-level phase structure**

binary phase structure that has more than two phase levels in one period

Note 1 to entry: Multi-level phase structure includes binary phase structure in its definition, however, each term is sometimes used as a synonym of the other.

Note 2 to entry: See Note 1 to entry to [3.1.2](#).

3.3.2.10**blazed diffractive optical element**

surface relief diffractive optical element able to concentrate the diffracted optical radiation energy in a specified diffraction order or orders using a prismatic structure in one period

3.3.2.11**deep grating**

surface relief grating whose phase depth is nearly equal to or greater than the incident wavelength

3.3.2.12**multi-diffraction-order structure**

diffractive optical element containing parts that generate different orders of diffraction

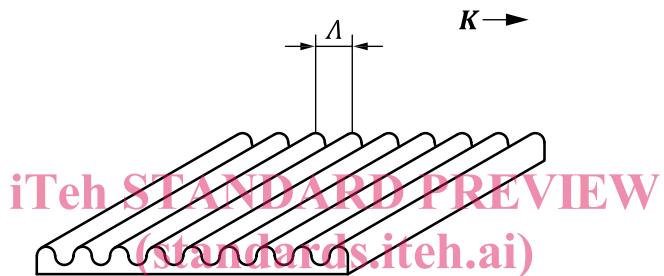
Note 1 to entry: When parts form concentric zones, this structure is often referred to either as a harmonic Fresnel structure or a super zone structure.

3.3.3 Periodic structure**3.3.3.1****period**

Λ

shortest length of the repetition in the spatial periodic structure of diffractive optical element

Note 1 to entry: For the surface relief grating, period Λ is shown in [Figure 1](#).

**Key**

Λ grating period

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K K-vector

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Figure 1 — Schematic representation of a surface relief grating

3.3.3.2**local period**

$\Lambda(x)$

local value of period $\Lambda(x)$, defined in terms of a function of the position vector x on the diffractive surface

3.3.3.3**spatial frequency**

v

number of modulations per unit of length (i.e. proportional to the reciprocal of the period)

3.3.3.4**local spatial frequency**

$v(x)$

reciprocal of the local period: $v(x) = 1/\Lambda(x)$

Note 1 to entry: Using the units in [Table 1](#), a factor of 10^3 needs to be taken into account due to the units used, with the local period $\Lambda(x)$ expressed in μm and the local spatial frequency $v(x)$ expressed in mm^{-1} .

3.3.3.5**subwavelength structure**

periodic structure whose period is smaller than λ/n , where n is the refractive index of the structure

Note 1 to entry: Depending on the incident angle, a subwavelength structure may not generate any diffracted optical radiation except for zero-order optical radiation. In this case the element is not a diffractive optical element. It is sometimes referred to as zero-order grating, anti-reflection structured surface or SWS.

3.3.3.6**chirped structure**

periodic structure whose period varies gradually

Note 1 to entry: A grating having a gradually varying period is referred to as chirped grating.

3.3.3.7**K-vector**

grating vector

K

vector, whose absolute value is $2\pi v$ and whose direction is parallel to the direction of periodicity of a grating

Note 1 to entry: The K-vector is also referred to as grating vector. For the surface relief grating, the K-vector is shown in [Figure 1](#).

3.3.3.8**amplitude of refractive index modulation**

~~ISO STANDARD PREVIEW~~ Δn when the index distribution of the diffractive surface is defined as

$$n(\mathbf{x}) = n_{av} + \Delta n \cos(\mathbf{K} \cdot \mathbf{x}) \quad (\text{standards.iteh.ai})$$

3.3.3.9**zone plate**

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diffractive optical element that functions as a lens and is composed of concentric zones

3.3.3.10**Fresnel zone plate**

diffractive optical element made up of concentric zones that are alternately opaque-transparent, in which the radius of each zone is proportional to the square root of that zone's number, with the number one being assigned to the centermost zone, and the number of each succeeding zone increasing by one

Note 1 to entry: There are two types of these plates: those whose odd-numbered zones are transparent and those whose odd-numbered zones are opaque. The former type Fresnel zone plate is shown in [Figure 2](#).

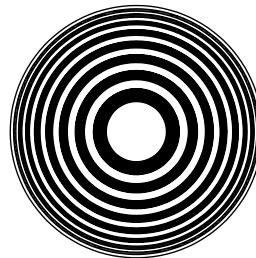


Figure 2 — Schematic representation of a Fresnel zone plate

3.3.3.11**phase Fresnel zone plate**

Wood zone plate

diffractive optical element made up of concentric zones similar to a Fresnel zone plate, but where the zones, rather than alternating between opaque / transparent, alternate in terms of their effect on the phase of incident optical radiation: