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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

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This document was prepared by Technical Committee ISO/TC 172, *Optics and Photonics*, Subcommittee SC 9, *Laser and electro-optical systems*.

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.

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/

3.1 Diffractive optics technologies

3.1.1
diffractive optics
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
binary optical element
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

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

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

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

3.3.2.6
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

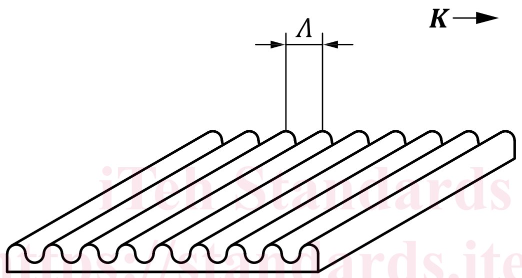
3.3.2.12
multi-diffraction-order structure
diffractive optical element containing parts that generate different orders of diffraction

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

$\boldsymbol{K}$ K-vector

Figure 1 — Schematic representation of a surface relief grating

3.3.3.2
local period
$\Lambda(\boldsymbol{x})$
local value of period $\Lambda(\boldsymbol{x})$, defined in terms of a function of the position vector $\boldsymbol{x}$ on the diffractive surface

3.3.3.3
spatial frequency
ν
number of modulations per unit of length (i.e. proportional to the reciprocal of the period)

3.3.3.4
local spatial frequency
$\nu(\boldsymbol{x})$
reciprocal of the local period: $\nu(\boldsymbol{x}) = 1/\Lambda(\boldsymbol{x})$

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 $\Lambda(\boldsymbol{x})$ expressed in µm and the local spatial frequency $\nu(\boldsymbol{x})$ expressed in mm^{-1}.

