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Lasers and laser-related equipment — Standard optical components —

Part 1: Components for the UV, visible and near-infrared spectral ranges

Lasers et équipements associés aux lasers — Composants optiques standards —

Partie 1: Composants pour les plages spectrales UV, visible et proche de l'infrarouge

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Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 11151 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 11151-1 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 9, *Electro-optical systems*.

ISO 11151 consists of the following parts, under the general title *Lasers and laser-related equipment — Standard optical components*:

— *Part 1: Components for the UV, visible and near-infrared spectral ranges*

— *Part 2: Components for the infrared spectral range*

Annex A of this part of ISO 11151 is for information only.

Introduction

Lasers are used in a wide variety of applications, including medicine, materials processing, information technology and metrology. Most lasers contain optical windows and mirrors (intracavity) and most laser systems use a variety of windows, beamsplitters, deflectors, mirrors and lenses. Those components used in high power laser applications must withstand high peak power and/or energy densities to avoid laser-induced damage, thus their component specifications are more demanding than those used in low power applications.

Lasers and laser-related equipment — Standard optical components —

Part 1: Components for the UV, visible and near-infrared spectral ranges

1 Scope

This part of ISO 11151 specifies requirements for laser components used in the near ultra-violet, visible and near infrared spectral ranges, from wavelengths 190 nm to 2 100 nm, and facilitates the supply of spare parts

— by specifying preferred dimensions and tolerances, thereby reducing the variety of types;

— by standardizing the specifications and removing barriers to trade;

— by establishing an agreed designation for item orders.

This part of ISO 11151 covers planar, plano-spherical and spherical substrates, lenses and optical components that are designed specifically as standardized optical components normally offered via catalogue from suppliers and intended for use with lasers.

This part of ISO 11151 includes component descriptions, materials employed, physical dimensions and manufacturing tolerances (including surface finish, figure and parallelism). Although most, but not all, of these components are coated (fully reflecting, partially reflecting or anti-reflecting) before incorporation into the laser system, this part of ISO 11151 does not include recommendations for the specification of coatings.

NOTE For optical components used in the infrared spectral range (> 2 100 nm), refer to ISO 11151-2. For the specification and testing of optical coatings, refer to the ISO 9211 series.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 11151. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 11151 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 9211-1:1994, *Optics and optical instruments — Optical coatings — Part 1: Definitions.*

ISO 9211-2:1994, *Optics and optical instruments — Optical coatings — Part 2: Optical properties.*

ISO 10110-1:1996, *Optics and optical instruments — Preparation of drawings for optical elements and systems — Part 1: General.*

ISO 11151-2:2000, *Lasers and laser-related equipment — Standard optical components — Part 2: Components for the infrared spectral range*.

3 Code for components covered

Table 1 specifies codes for the components to which this part of ISO 11151 is applicable.

Table 1 — Component codes

Component form	Code
Optical flats	OF
Circular windows — flat	WC
Elliptical windows — flat	WE
Rectangular windows — flat	WR
Output couplers — flat	OC
Mirrors — flat	MF
Mirrors — convex	MX
Mirrors — concave	MV
Plano-convex lenses	PX
Plano-concave lenses	PV
Symmetric biconvex lenses	BX
Symmetric biconcave lenses	BV

4 Materials

This part of ISO 11151 is applicable to components employed in the near ultra-violet, visible and near infrared wavelength regions, 190 nm to 2 100 nm. A wide range of materials may be used, such as:

— borosilicate crown glass;

— fused silica;

— UV-grade fused silica;

— calcium fluoride.

In view of the wide variety of materials available, the use of specific code numbers for each material has not been formalized. Manufacturers and designers shall therefore specify the exact materials used/required. The material specification shall be given as stated in subclause 4.7 of ISO 10110-1:1996. If birefringent materials are used/specified, the orientation of the optical axis relative to the geometric axes of the components shall be stated.

5 Requirements for quality

Preferred specifications and classes for material and surface quality are set out in Tables 2 to 6, using terminology in accordance with parts 1 to 7 of ISO 10110. The standard of quality for components to be used with lasers is in general higher than for general optics. There is also a quality requirement for optics to be used inside a laser cavity (intracavity use) distinctly different from that for optics used outside the laser cavity, due to the extremely high power and energy densities developed inside the laser cavity and the possibility of laser-induced damage.

In consequence this part of ISO 11151 promulgates two classes of quality[1]. Class A optics are designed for intra-cavity optics, output couplers and for components used in areas of extremely high power (energy) density. Class A optics have significantly tighter form tolerance (3/...) and surface imperfection tolerance (5/...) figures than do Class B optics. It should also be noted that the surface dig and pit critical dimensions for laser-induced damage are $\lambda/10$ to 10λ, where λ is the wavelength of operation of the laser.

The differences between the material/fabrication tolerances for flat circular windows, WC, flat output couplers, OC, and flat mirrors, MF, and those for optical flats, OF, are due to the far higher fabrication tolerances for the latter and the fact that there is only one fabrication tolerance irrespective of the component diameter. The parallelism fabrication tolerances are $(0 \pm 10)''$ (angular seconds) for optical flats, while they are $15\ ^{+5}_{-1}{}'$ (angular minutes) for the other components. This is because optical flats are designed to generate constructive interference within the component, while the others aim to minimize this effect.

Table 2 — Material and surface fabrication tolerances for lenses

Diameter mm	Material tolerances			Working tolerances				
	Stress birefringence 0/...	Bubbles and inclusions 1/...	Inhomo-geneity and striae 2/...	Class A surface form 3/...	Class B surface form 3/...	Centring 4/...	Class A surface imperfection 5/...	Class B surface imperfection 5/...
5 to 15	10	2 × 0,063	2;4	–(0,2/0,2)	–(0,4/0,4)	2′	1 × 0,016	1 × 0,063
> 15 to 30	10	3 × 0,063	2;4	–(0,3/0,3)	–(0,6/0,6)	2′	1 × 0,016	1 × 0,063
> 30 to 51	10	3 × 0,100	2;3	–(0,5/0,5)	–(1,0/1,0)	2′	2 × 0,016	2 × 0,063
> 51 to 102	10	5 × 0,100	2;3	–(0,6/0,6)	–(1,0/1,0)	2′	3 × 0,016	3 × 0,063

Table 3 — Material and surface fabrication tolerances for mirrors (except output couplers)

Diameter mm	Material tolerances			Working tolerances				
	Stress birefringence 0/...	Bubbles and inclusions 1/...	Inhomo-geneity and striae 2/...	Class A surface form 3/...	Class B surface form 3/...	Centring 4/...	Class A surface imperfection 5/...	Class B surface imperfection 5/...
5 to 15	10	NA	NA	–(0,2/0,2)	–(0,4/0,4)	2′	1 × 0,010	1 × 0,040
> 15 to 30	10	NA	NA	–(0,2/0,2)	–(0,6/0,6)	2′	2 × 0,010	2 × 0,040
> 30 to 51	10	NA	NA	–(0,3/0,3)	–(1,0/1,0)	2′	3 × 0,010	3 × 0,040
> 51 to 102	10	NA	NA	–(0,5/0,5)	–(1,0/1,0)	2′	5 × 0,010	5 × 0,040
NA: not applicable.								

1) The quoted grade values assume that most of the incident radiation is scattered out of the beam by the imperfection. This is the case where the radiometric obscuration equals the area obscuration. If the imperfection is partially transmitting, its actual area could be larger than is suggested by these values. A method for measuring surface imperfections is described in ISO 14997 (see Bibliography).

Table 4 — Material and surface fabrication tolerances for flat output couplers

Diameter mm	Material tolerances			Working tolerances		
	Stress birefringence 0/...	Bubbles and inclusions 1/...	Inhomogeneity and striae 2/...	Class A surface form 3/...	Class A surface imperfection 5/...	Parallelism
5 to 15	10	2 × 0,063	2;4	–0,2(0,2/0,2)	1 × 0,010	15′
> 15 to 30	10	2 × 0,063	2;4	–0,3(0,3/0,3)	2 × 0,010	15′
> 30 to 51	10	3 × 0,100	2;3	–0,5(0,5/0,5)	3 × 0,010	15′
> 51 to 102	10	5 × 0,100	2;3	–0,6(0,6/0,6)	5 × 0,010	15′

Table 5 — Material and surface fabrication tolerances for optical flats

Diameter mm	Material tolerances			Working tolerances		
	Stress birefringence 0/...	Bubbles and inclusions 1/...	Inhomogeneity and striae 2/...	Class A surface form 3/...	Class A surface imperfection 5/...	Parallelism
5 to 102	10	2 × 0,063	2;4	0,2(0,2/0,2)	1 × 0,010	± 10″

Table 6 — Material and surface fabrication tolerances for windows

Diameter mm	Material tolerances			Working tolerances				
	Stress birefringence 0/...	Bubbles and inclusions 1/...	Inhomogeneity and striae 2/...	Class A surface form 3/...	Class B surface form 3/...	Class A surface imperfection 5/...	Class B surface imperfection 5/...	Parallelism
5 to 15	10	2 × 0,063	2;4	–(0,2/0,2)	2(0,4/0,4)	1 × 0,010	1 × 0,040	15′
> 15 to 30	10	2 × 0,063	2;4	–(0,3/0,3)	3(0,6/0,6)	2 × 0,010	2 × 0,040	15′
> 30 to 51	10	3 × 0,100	2;3	–(0,5/0,5)	5(1,0/1,0)	3 × 0,010	3 × 0,040	15′
> 51 to 102	10	5 × 0,100	2;3	–(0,6/0,6)	6(1,0/1,0)	5 × 0,010	5 × 0,040	15′

6 Dimensional tolerances

6.1 Preferred dimensions

It is strongly recommended that all dimensions for components be specified in metric units. However it is recognized that, at least for the time being, there is also a market for components whose dimensions are specified in imperial units. Preferred dimensions for this latter class are given in annex A.

It should be noted that while the nomenclature (see clause 8) has been designed so that non-preferred dimensions can be included if strictly necessary, it is strongly recommended that both designers and manufacturers adopt the

preferred dimensions. The preferred (metric) dimensions and dimensional tolerances are listed in Tables 7, 8 and 9 using reference terminology as defined in Figure 1. Note that all components shall have protective bevels.

Table 7 — Preferred dimensions for circular or rectangular flat components [see Figure 1 a) to c)]

Dimensions in millimetres

Diameter or minor edge length	Major edge length	Tolerance of diameter or edge length	Thickness ± 0,2
4	6,5	–0,10	1 or 2
5	8	–0,10	1 or 2
6	10	–0,10	1 or 2
8	13	–0,10	2 or 4
10	16	–0,10	2 or 4
15	24	–0,15	2 or 4
20	32	–0,15	4 or 8
25	40	–0,15	4 or 8
30	48	–0,15	4 or 8
40	63	–0,15	4 or 8
50	80	–0,15	4 or 8
60	100	–0,20	4 or 8
75	120	–0,20	10 or 20
80	130	–0,20	10 or 20
100	160	–0,20	10 or 20

Table 8 — Standardized lens dimensions [see Figure 1 d)]

Dimensions in millimetres

Diameter	Diameter tolerance	Edge thickness [a]	
		Convex ± 0,2	Concave ± 0,2
5	– 0,10	2	4
8	– 0,10	2	4
10	– 0,10	2	4
15	– 0,15	3	7
20	– 0,15	3	7
25	– 0,15	3	7
30	– 0,15	4	15
40	– 0,15	4	15
50	– 0,15	4	15
75	– 0,20	5	25
100	– 0,20	5	25

[a] For plano-convex and plano-concave lenses only (see 6.5).