Introduction to ISO 10110

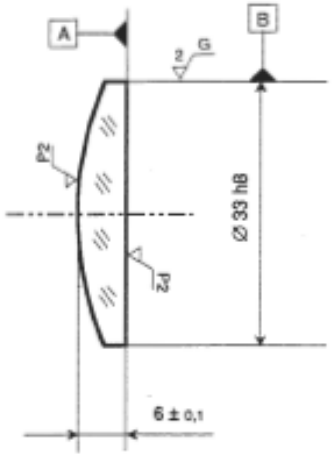
Preparation of drawings for optical elements and systems

and a few words about other optical standards

Parts of ISO 10110

1. General – Differences between optical and mechanical drawings
2. Material imperfections – Stress birefringence – 0/
3. Material imperfections – Bubbles and inclusions – 1/
4. Material imperfections – Inhomogeneity and striae – 2/
5. Surface form tolerances – 3/
6. Centering tolerances – 4/
7. Surface imperfection tolerances – 5/
8. Surface texture
9. Surface treatment and coating
10. Table representing data of a lens element
11. Non-toleranced data
12. Aspheric surfaces
13. Laser irradiation damage threshold

Simple optical element drawing



Left Surface:	Material Specification:	Right Surface:
R 37.449 CX Øe 30.5 Prot. chamfer 0.4 - 0,6 (λ) AR 209.1060 3/ 5(1) 4/ 1,4' 5/ 5x0.1; C 5x0.16; L 3x0.004; E 0.4 6/ 6KWcm^{-2};1060nm;10	Hoya LaC9 or Schott LaK9 n(1060nm) 1.6759±0.001 v - 0/ 20 1/ 5x0.1 2/ 1:2	R ∞ Øe 29 Prot. chamfer 0.4 - 0,6 (λ) AR 209.1060 3/ 5(1) 4/ - 5/ 5x0.1; C 5x0.16; L 3x0.004; E 0.4 6/ 6KWcm^{-2};1060nm;10

Indications according to ISO 10110

Lens 114.379

Part 2
Material imperfections – Stress birefringence

Indication in drawing – 0/X where X is the max. birefringence in nm/cm

OPD due to stress birefringence = $a*\sigma*K$ where

a = sample path length in cm

σ = residual stress in N/mm

K = difference in photoelastic constants in 10^{-7} mm/N

A retardation > 20 nm/cm corresponds to a “coarse” anneal

A retardation of < 10 nm/cm is referred to as “fine” anneal

Part 3
Imperfections – Bubbles and inclusions

Indication in drawing – 1/NxA where

N is the number of allowed bubbles or inclusions

A is the length of the side of a square in units of mm

(Thus A^2 is the area the bubble or inclusion obscures)

The obscured area may be sub-divided into smaller bubbles provided the obscured area is no larger than that designated. Table shows an example

A typical designation might be 1/3x.1

The same system of designation is used for surface defects in

Part 7

Grade numbers [mm]	Multiplication factors			
	1	2,5	6,3	16
	0,006			
	0,010	0,006		
	0,016	0,010	0,006	
	0,025	0,016	0,010	0,006
	0,040	0,025	0,016	0,010
	0,063	0,040	0,025	0,016
	0,10	0,063	0,040	0,025
	0,16	0,10	0,063	0,040
	0,25	0,16	0,10	0,063
	0,40	0,25	0,16	0,10
	0,63	0,40	0,25	0,16
	1,0	0,63	0,40	0,25
	1,6	1,0	0,63	0,40
	2,5	1,6	1,0	0,63
	4,0	2,5	1,6	1,0

Part 4
Imperfections – Inhomogeneity and striae

Indication in drawing – 2/A;B where

A is the class number for inhomogeneity

B is the class for striae

Table 1 Inhomogeneity classes

Class	Maximum permissible variation of refractive index within a part [10^{-6}]
0	± 50
1	± 20
2	± 5
3	± 2
4	± 1
5	± 0,5

Table 2 Classes of striae

Striae class	Density of striae causing an optical path difference of at least 30 nm in %
1	≤ 10
2	≤ 5
3	≤ 2
4	≤ 1
5	Extremely free of striae The restriction to striae exceeding 30 nm does not apply Further information to be specified in a note

Part 5
Surface form tolerances

Indication in drawing – 3/A(B/C)

where A is the maximum spherical sag error from test plate

or a dash (-) where the radius tolerance is a dimension

B is the p-v maximum irregularity

C is the maximum rationally symmetric p-v figure error

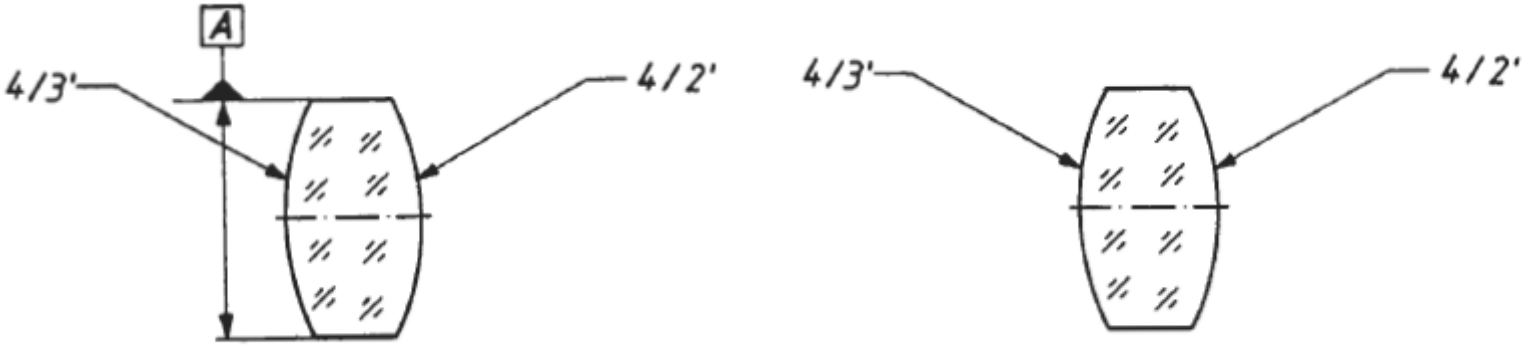
The units are fringes (or fringe spacings)

There is a provision for RMS specification in fringes

Part 6
Centring tolerances

Indication in drawing – 4/α

where α is the angle between the datum and surface



The indication is always the same for each surface but the method of indicating the datum follows mechanical drawing practice

A polished surface can be a datum and is often the best choice of datum

Part 7
Surface imperfection tolerances

Indication in drawing – 5/NxA

Where N is the number of allowed imperfections

A is the length of the side of a square in mm

so NxA^2 is the total area obscured by imperfections

Coating imperfections are preceded by a C

Long scratches by an L

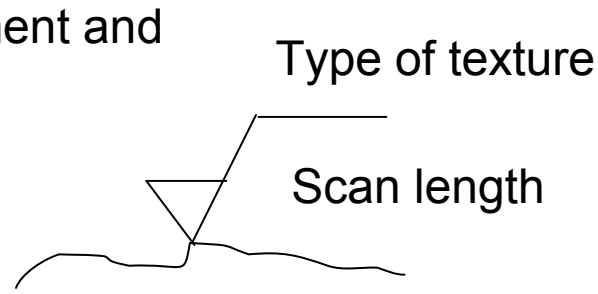
Edge chips by an E

Sub-division is permissible the same as with bubbles and inclusions

Example – 5/NxA; CN’xA’; LN”xA”, EA’”

Part 8
Surface texture

Indication on drawing -



Type of texture – G for ground or matt, P for polished

Type of measurement – Rq, RMS or PSD (Power spectral density)

Scan length and increment – minimum resolution and scan distance

Part 9
Surface treatment and coating

Indication on drawing -  for optical thin film coatings

Symbol touches surface or extension line from surface affected

Draw a leader from symbol to box containing coating specification

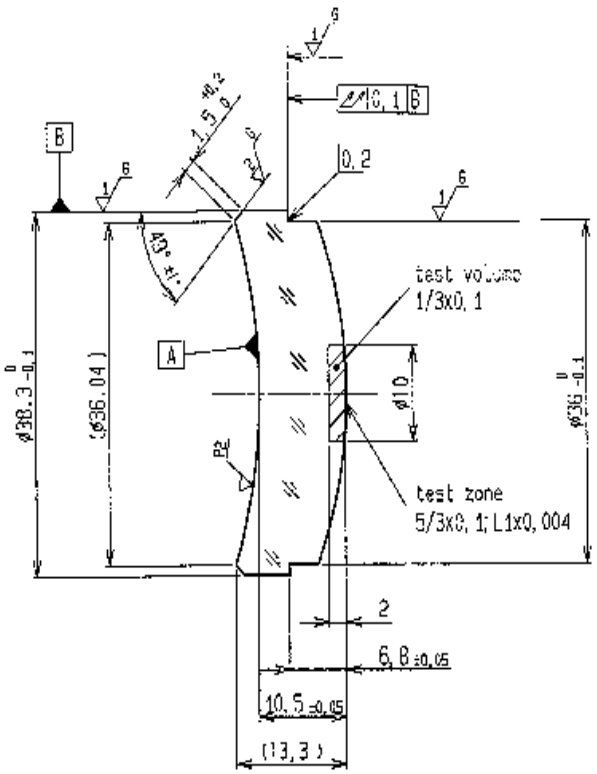
ISO 9211 Optical coatings explains coating specifications

Unless otherwise stated wavelength is assumed 546.07 nm

Edge blackening or protective coating indicated by thick “chain” line (line type J, ISO 128) adjacent to the applicable surface

Part 10
Table representing data of a lens element

- Shows the simple element drawing shown at beginning
- Table 1 is useful check list to see if drawing is complete
- Also a quick summary of the symbols used in optical drawings
- Several examples of lens element drawings



Left Surface:	Material Specification:	Right Surface:
R 60,43 CC **Øe** 35 **Prot. chamfer** C,2 - 0,4 (λ) AR 207b **3/** 2(0,5) **4/** - **5/** 5x0,16; L 2x0,04; E 0.5	BK7 ne 1,51872±0,001 ve 63,96±0,8% **0/** 10 **1/** 5x0,16 **2/** 1;2	**R** 50,17 CX **Øe** 34 **Prot. chamfer** 0,2 - 0,4 (λ) - **3/** 3(1) **4/** 2' **5/** 5x0,16; L 2x0,04; E 0,5 To be cemented
Indications according to ISO 10110	Lens 124.736	

Figure 3 Example of tabular indication of data for a lens element

Part 11
Non-toleranced data

Property	Range of maximum (diagonal) dimension of the part [mm]			
	up to 10	over 10 up to 30	over 30 up to 100	over 100 up to 300
Edge length, diameter [mm]	±0,2	±0,5	±1	±1,5
Thickness [mm]	±0,1	±0,2	±0,4	±0,8
Angle deviation of prisms and plate	±30'	±30'	±30'	±30'
Width of protective chamfer [mm]	0,1 - 0,3	0,2 - 0,5	0,3 - 0,8	0,5 - 1,6
Stress birefringence acc. to ISO/DIS 10110-2 [nm/cm]	0/20	0/20	-	-
Bubbles and inclusions acc. to ISO/DIS 10110-3	1/3x0,16	1/5x0,25	1/5x0,4	1/5x0,63
Inhomogeneity and striae acc. to ISO/DIS 10110-4	2/1;1	2/1;1	-	-
Surface form tolerances acc. to ISO/DIS 10110-5	3/5(1)	3/10(2)	3/10(2) (all Ø 30)	3/10(2) (all Ø 60)
Centring tolerances acc. to ISO/DIS 10110-6	4/30'	4/20'	4/10'	4/10'
Surface imperfection tolerances acc. to ISO/DIS 10110-7	5/3x0,16	5/5x0,25	5/5x0,4	5/5x0,63

Part 12
Aspheric surfaces

- Just the sag formulas in most lens design software
- One comment on Zernike polynomials
  - The standard uses the FRINGE monomial p-v ordering
  - I think this is short sighted
  - You should use double indices as in α_i^j
  - Where I is the power of the radial parameter, and
  - j is the angular order

Part 13
Laser irradiation damage threshold

- Here to let you know this part exists
- Has commercial use for lasers used in processing materials
- These days commercial lasers powerful enough to damage coatings

- Just looked at ISO 10110
- There are over 200 ISO optical standards dealing with
  - Coatings
  - Environmental tests
  - Microscopes, telescopes, endoscopes and ophthalmics
  - Laser devices
  - Optical materials and glasses
  - Vocabulary and definitions
- More are being added all the time
- Also there is a whole body of Mechanical standards
  - TR 5460 is great on GDT
- The US participates in the standards writing
- The standards are copywritten material
  - Proceeds from their purchase supports standards writing efforts