

TIE-04 Test report for delivery lots of optical glass

Introduction

With every delivery of fine annealed optical glass the customer receives a test report in accordance with ISO 10474. The test report contains non-specific test results to confirm the compliance of the delivery with the order. That means that random representative test samples were inspected during production to ensure the compliance with the order. The specific choice of test samples and inspection procedures ensures the validity of results for all parts of the delivery lot even if they were not individually tested.

1. Backtracking of material properties and production information of lots	1
2. Compilation of delivery lots	1
3. Marking of the delivery lot and batches	2
4. Details in the test report of fine annealed optical glass	2
5. Annealing schedule of coarse annealed optical glass	4
6. Additional test certificates	6
7. Literature	6

1. Backtracking of material properties and production information of lots

A batch is numbered directly after melting and coarse annealing. The batch number is kept in all further processing steps and therefore allows to backtrace all important material properties and production information.

We recommend to preserve the batch numbers of glass pieces used for following processing steps. Statements on quality of the delivered glass can only be made with reference to the respective batch numbers.

2. Compilation of delivery lots

Delivery lots are compiled from batches according to their refractive index and Abbe number specification. The maximum scattering of refractive index of single batches within a lot is $\pm 10 \cdot 10^{-5}$ (pressings: $\pm 20 \cdot 10^{-5}$) The maximum scattering tolerance for precision molding glasses is limited by the refractive index tolerance step 3. In general the delivery lot contains adjacent batches taken from a single production run. SCHOTT will add material from other production runs that fit the optical position of the respective delivery lot if the ordered quantity exceeds the quantity of a single production run.

	n_d	v_d
Step 0.5*	± 0.0001	$\pm 0.1\%$
Step 1	± 0.0002	$\pm 0.2\%$
Step 2	± 0.0003	$\pm 0.3\%$
Step 3	± 0.0005	$\pm 0.5\%$

* only for selected glass types

Tab. 1: Tolerances for refractive index and Abbe number (according to ISO 12123) [1]

Fine annealed glass, cut blanks		Pressings	
Designation	Refractive index variation	Designation	Refractive index variation
SN	$\pm 10 \cdot 10^{-5}$	LN	$\pm 20 \cdot 10^{-5}$
S0	$\pm 5 \cdot 10^{-5}$	LH1	$\pm 10 \cdot 10^{-5}$
S1	$\pm 2 \cdot 10^{-5}$	LH2	$\pm 5 \cdot 10^{-5}$

Tab. 2: Tolerance of refractive index variation within a lot of fine annealed glass (according to ISO 12123) and within a lot of pressings [1]



TIE-04 Test report for delivery lots of optical glass

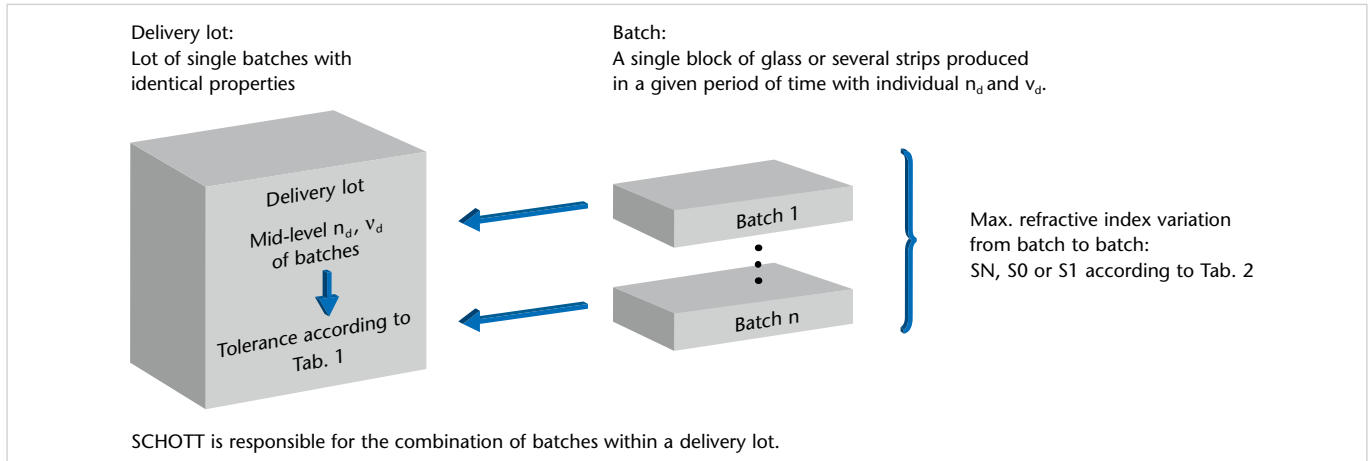


Fig. 1: Delivery lot compilation of glass for hot processing and fine annealed glass [1]

3. Marking of the delivery lot and batches

The Lot-ID number is assigned automatically by the computer system and is not related to any production information. A new Lot-ID is assigned for each delivery and only related to the delivered lot. The delivery lot contains batches, which are the smallest administrated units of materials. Batches are marked with the production serial number, e.g. C100001234. A batch of block glass for further cold processing contains a single glass block. In the case of processed glass 100 single glass discs could also be one batch.

4. Details in the test report of fine annealed optical glass

This chapter describes the test report of fine annealed optical glass for cold processing purpose. It is assumed that no additional heat treatment of the glass with temperatures near T_g will be applied during further processing. In general the delivery lot will not be compiled of glass with homogeneous annealing rate history. Therefore even in the case of correct fine annealing additional heat treatment might lead to greater scattering of refractive index than promised in the test report. The given limit values for the stress birefringence will be kept even for delivery lots with inhomogeneous history of annealing rates.

The test report as shown on the next page contains the Lot-ID, the order number, the SCHOTT customer number, the glass type, the refractive index and Abbe number steps, the scattering tolerance of refractive index, a list of all batches of the delivery lot, details on the mid-level optical position of the delivery lot (between maximum and minimum value of refractive index and Abbe number in the lot), the difference of the refractive index and the Abbe number from the catalog values. The spectral internal transmittance and the color code can be added on special request.

The refractive index and the Abbe number of the d-line are based on measurements. All values of other spectral lines then the d-line are calculated using the relative dispersion values (or using the Sellmeier coefficient) of the glass given in the catalog.

Example of test report for fine annealed optical glass (subject to change)

→ ← | [Back to index](#)

TIE-04 Test report for delivery lots of optical glass

SCHOTT

Test Report / Werkszeugnis
 ISO 10474 - 2.2 2016/05/30

Delivery Note / Lot-ID/
 Lieferschein / Lieferlos
 Order Position of/
 Auftrag Position vom

Customer / Kunde

Glass Type / Glasart **N-BAK4**
 Glass code / Glaskennziffer **569560.305**
 n_d / v_d -Step/-Stufe **1 / 1**

Scattering / Streuung +/- **0.00010**

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Batches / Chargen
 Dxxxx595

n_d	1.56863	-0.00020*	v_d	55.99	0.01*	0.02%*
n_e	1.57105	-0.00020*	v_e	55.72	0.02*	0.04%*

	Lambda [μm]	n		n _F - n _C	0.01016
n_g	0.4358	1.58128		$n_d - n_C$	0.00308
$n_{F'}$	0.4800	1.57629		$n_F - n_d$	0.00708
n_F	0.4861	1.57571		$n_F - n_e$	0.00466
n_e	0.5461	1.57105		$n_g - n_F$	0.00557
n_d	0.5876	1.56863		$n_{F'} - n_{C'}$	0.01025
$n_{632.8}$	0.63280	1.56650		$n_{F'} - n_e$	0.00524
$n_{C'}$	0.6438	1.56604			
n_C	0.6563	1.56555			
n_r	0.7065	1.56381			
n_s	0.8521	1.56015			
n_t	1.01398	1.55736			

Wavelengths in full precision see catalog * Deviation from catalogue value
 Wellenlängen in voller Genauigkeit siehe Katalog * Abweichung vom Katalogwert

This test report has been printed via EDP. It is valid without signature.

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Fig. 2: Test report for delivery lots of fine annealed optical glasses

[→](#) [←](#) | [Back to index](#)



TIE-04 Test report for delivery lots of optical glass

For precision molding glasses we additionally report the glass transformation temperature. The refractive index values given are reference values based on a reference annealing rate of 2 K/h. The actual refractive index of the precision molding glass batches will be different. More information on precision molding glasses can be found in the technical information no. 40.

Glasses for precision molding in general are coarse annealed glasses. The customer will receive a test report with the refractive index and Abbe number of the delivery lot based on a reference annealing of 2 K/h. The actual refractive index of the glass within this lot will differ from this value.

5. Annealing schedule of coarse annealed optical glass

Delivery lots of glasses for reheat pressing do have homogeneous annealing rates and will be delivered with an annealing schedule as certificate. The certificate contains values of the mid-level refractive index and Abbe number of the lot at a given annealing rate and tolerable annealing rates for all refractive index and Abbe number steps. This information is generated with samples whose state of annealing differs from the respective glass. The glass in delivery lots of glass for reheat pressing is only coarse annealed and therefore in general not suited for the cold processing and direct use in optical components (cutting, grinding, polishing). On special demand lots of fine annealed glass can also be delivered with homogeneous annealing rates and additional annealing schedules.

Example of an annealing schedule (subject to change)

[→](#) [←](#) | [Back to index](#)

TIE-04 Test report for delivery lots of optical glass

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Annealing Schedule / Kühlvorschrift 30.05.2016

Delivery Note / Lot-ID / Lieferschein / Lieferlos 01.06.2016

Order / Item / of Auftrag / Position / vom

Customer / Kunde

Glass Type / Glasart N-SK2

Glass code / Glaskennziffer 607567.355

Scattering / Streuung +/- 0.00003

Ref. Values / Ref.-Werte*

	$n_{d,e}$	$v_{d,e}$	v_{k0} [K/h]
d-Line	1.60736	56.58	2.0
e-Line	1.60992	56.30	

Other Values / andere Werte*

	n_x
g-Line	1.62072
F-Line	1.61484
F'-Line	1.61546
C-Line	1.60411
C'-Line	1.60463

Catalog / Katalog

	$n_{d,e}$	$v_{d,e}$
d-Line	1.60738	56.65
e-Line	1.60994	56.37

Annealing Parameters / Kühl-Parameter

m_{nd}	-0.00102
m_{FC}	
m_{vd}	-0.0951

Glass Data / Glasdaten

T_g	659 °C
T_{10}	7.6 823 °C
$a(20;300)$	$7.10 \cdot 10^{-6}/K$

Step / Stufe	Refractive Index / Brechzahl n_d			Abbe Number / Abbezahl v_d			Annealing Rate Range [K/h] / Kühlraten-Bereich [K/h]	
	+/-	Tol / min	Tol / max	+/- %	Tol / min	Tol / max	$v_{k,min}$	$v_{k,max}$
4/4	0.0010	1.60638	1.60838	0.80	56.20	57.10	0.21	17.08
3/4	0.0005	1.60688	1.60788	0.80	56.20	57.10	0.66	5.52
3/3	0.0005	1.60688	1.60788	0.50	56.37	56.93	0.66	5.52
2/3	0.0003	1.60708	1.60768	0.50	56.37	56.93	1.04	3.52
2/2	0.0003	1.60708	1.60768	0.30	56.48	56.82	1.04	3.52
1/2	0.0002	1.60718	1.60758	0.30	56.48	56.82	1.30	2.81
1/1	0.0002	1.60718	1.60758	0.20	56.54	56.76	1.30	2.81

*values based on a reference annealing rate of v_{k0} , actual value will be different / Werte basieren auf Referenzkühlrate v_{k0} , die tatsächlichen Werte sind andere

Internal Transmittance / Reintransmission (400nm;10mm) 0.998

This glass is not suited for the direct fabrication of finished optical elements via cold processing. Annealing rates are given in K/h. $v_k > 100$ K/h will be denoted as 100 K/h, $v_k < 0,1$ K/h as 0,1 K/h.

List of batches
Dxxxx781 Dxxxx782 Dxxxx783

Dieses Glas ist nicht für die direkte Herstellung von fertigen optischen Elementen auf kaltem Wege geeignet. Einheit der Kühlrate ist K/h. $v_k > 100$ K/h werden als 100 K/h, $v_k < 0,1$ K/h als 0,1 K/h angegeben.

Liste der Chargen
Dxxxx784 Dxxxx785 Dxxxx786 Dxxxx787

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Mainz, Germany

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Fig. 3: Annealing schedule for delivery lots of coarse annealed optical glasses for reheat pressing

→ ← | [Back to index](#)



TIE-04 Test report for delivery lots of optical glass

6. Additional test certificates

Further properties of the delivery lot that were requested by the customer will be certified with additional entries within the test report or as additional test certificates.

7. Literature

[1] [SCHOTT Optical Glass Pocket Catalog](#)

[←](#) | [Back to index](#)



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