

**Application:** This standard is applicable to direct drawn tubes produced with **ilmasil® PN 235** base material

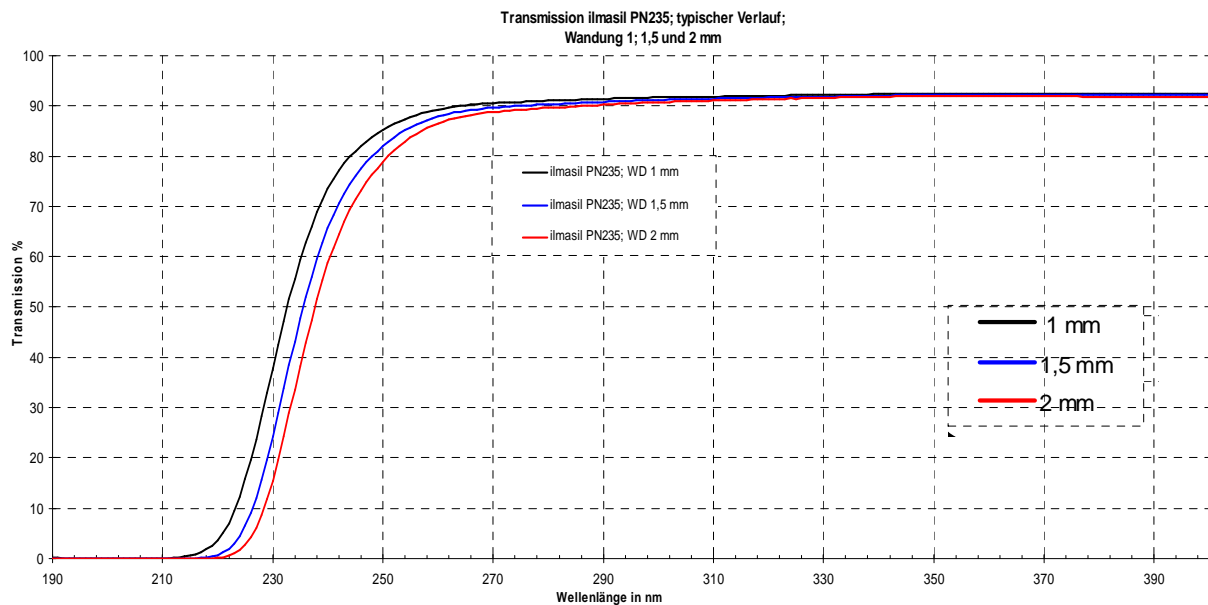
## 1 Optical Properties

### 1.1 Transmission

#### 1.1.1 Guaranteed values

Wavelength $\lambda$ [nm]	200	220	230	240	254	300
wallthickness 1 mm	0%	< 5%	< 50%	>65%	>85%	>89%
wallthickness 1,5 mm	0%	< 3%	< 35%	>55%	>83%	>89%
wallthickness 2 mm	0%	< 3%	< 25%	>45%	>80%	>89%

#### 1.1.2 Typical Transmission for UV-range



**Remarking:** All values are valid for measurement on a flat surface. Measurements on tube surface may vary depending on the tube diameter



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## 1 Hydroxyl Content (OH-content)

**Definition:** degree of hydroxyl groups in the tube wall (excluding outer surface)  
The typical content in ilmasil PN 235 fused quartz tubes is 35 ppm

**Limit:** max. 55 ppm

**Remark:** After thermal treatment, a decrease of maximum 3 ppm is obtainable by tempering the material at 1000°C under vacuum for a period of 30 hours.

## 2 Visual Characteristics

The term “visual” is used for the inspection method where the tubing to be inspected at a distance of 0.3 – 0.6 m from the inspector, with a white/black background under general inspection illumination.

### 3.1 Bubbles

#### Enclosed Bubbles

**Definition:** a spherical void, wholly within the tube wall

**Limit:**

**Tube outer diameter (OD) ≤ 40 mm and wallthickness (Wt) ≤ 4 mm**

Tube size	Length [mm]	Width [mm]	Max.Number per 100 mm tube length [pieces]		Total length of all detected bubbles per 100 mm tube length [mm]
OD ≤ 40 mm; Wt ≤ 1 mm	> 20	max. 0,2	0		40 mm
	> 10 - 20	max. 0,2	*		
	> 5 – 10	max. 0,2	2	10	
	> 4 – 5	max. 0,2	3		
	> 2 – 4	max. 0,2	10		
	> 1 – 2	max. 0,2	20		Not specified
	> 0,5 – 1	max. 0,2	50		
OD ≤ 40 mm; Wt > 1 – 2 mm	> 20	max. 0,2	0		40 mm
	> 10 - 20	max. 0,2	*		
	> 5 – 10	max. 0,2	2	10	
	> 4 – 5	max. 0,2	3		
	> 2 – 4	max. 0,2	10		
	> 1 – 2	max. 0,2	30		Not specified



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Tube size	Length [mm]	Width [mm]	Max.Number per 100 mm tube length [pieces]	Total length of all detected bubbles per 100 mm tube length [mm]	
OD ≤ 40 mm; Wt >2 -4 mm	> 20	max. 0,2	0	50 mm	
	> 10 - 20	max. 0,2	*		
	> 5 – 10	max. 0,2	2		
	> 4 – 5	max. 0,2	5		
	> 2 – 4	max. 0,2	15	15	
	> 1 – 2	max. 0,2	30	30	Not specified
	> 0,5 – 1	max. 0,2	80	80	

\* 2 bubbles > 10 – 20 mm are permitted per 1 meter tube length  
 Bubbles in width and length < 0.3 mm are not counted  
 Bubbles in width and length > 0.3 to 2 mm: Total bubble cross section: max. 50 mm<sup>2</sup> per 100 cm<sup>3</sup> (as per DIN 58927)  
 Bubble clusters: not permitted for length > 20 mm- judge the whole cluster to the limits of a single bubble

**2. Tube outer diameter (OD) < 40 and wallthickness (Wt) > 4 mm  
 Tube outer diameter (OD) > 40 mm**

Tube size	Length [mm]	Width [mm]	Max.Number per 100 mm tube length [pieces]	Total length of all detected bubbles per 100 mm tube length [mm]
OD > 40 mm;	> 20		0	50 mm
	> 10 - 20	max. 0,2	*	
	> 5 - 10	max. 0,2	2	
	> 4 – 5	max. 0,2	5	
	> 2 – 4	max. 0,2	15	15

\* 2 bubbles > 10 – 20 mm are permitted per 1 meter tube length  
 Bubbles in width and length < 0.3 mm are not counted  
 Bubbles in width and length > 0.3 to 2 mm: Total bubble cross section: max. 50 mm<sup>2</sup> per 100 cm<sup>3</sup> (as per DIN 58927)  
 Bubble clusters: not permitted for length > 20 mm- judge the whole cluster to the limits of a single bubble

Inspection: visual, scale magnifier



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### Open Bubbles

Definition:	A void, open to the outer or inner surface >0,3 mm
Limit:	max. number: 5 per meter tube length with max. length 3 mm and max. depth 0.2 mm
Inspection:	visual, scale magnifier

### **3.2 Inclusions**

Definition:	included foreign particles (spots), visible by color difference
Limit:	inclusions > 0.1 mm are not permitted
Inspection:	visual, scale magnifier for detection of white spots use a black background for detection of black spots use a white background

### **3.3 Striation**

Definition:	transparent inclusions, causing apparent optical distortion
Limit:	scattered colorless striations are permitted colored striations are not permitted
Inspection:	visual on a crosswalk-background

### **3.4 Surface defects**

#### 3.4.1 Scratches

Definition:	a fine line abrasion on outer surface (line wider as 0.1 mm) visible by unaided eye with a black background
Limit:	permitted if not perceptible with gloved fingers  if perceptible with gloved fingers these limits are to apply:  in axial direction: scattered scratches with length of max.. 50 mm length; total length of all scratches: max. 10% of tube length in peripheral direction: max. total length: OD * II not permitted if completely circumferential
Inspection:	visual, caliper, scale magnifier



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### 3.4.2 Scuff

Definition:	broad surface abrasion (groups of lines wider as 0.1 mm).
Limits:	No individual OD scuff wider than 10 mm or longer than 5 mm Total area of all scuffs on the outer surface, added together, are to be no more than 0.25% of tube outer surface area.
Inspection:	visual, caliper

### 3.4.3 Waterspots, Fingerprints, Cutter dust

Definition:	removable surface deposits left by washing residue or finger touch
Limit:	permitted to a minor degree
Inspection:	visual

### 3.4.4 Vapor

Definition:	a broad area or band of white haze on the inner or outer surface visible to the unaided eye on a black background
Limits:	not permitted
Inspection:	visual

### 3.4.5 Structure

Definition:	Optical distortion caused by marginal variations in the wall thickness
Limit:	permitted if not perceptible with gloved fingers permitted if low-contrast appearance (comparison with limit sample)
Inspection:	visual



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### 3.4.6 Bubble Scars

Definition: Depressions on the surface caused by healed or collapsed bubbles

Limit: not permitted if perceptible with gloved fingers

Inspection: visual (inspection to be performed in axial direction)

### 3.4.7 Surface adhesions

Definition: non-colored quartz particles fused into the surface causing a protrusion

Limit: not permitted if any sharp edges

Inspection: visual, manually

## 4 Further applicable documents

S-101-05 Specification and Inspection Criteria for Tubes: Dimensional Characteristics

S-101-01-PN Material Standard: Clear Fused Quartz [ilmasil® PN 235](#)