

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

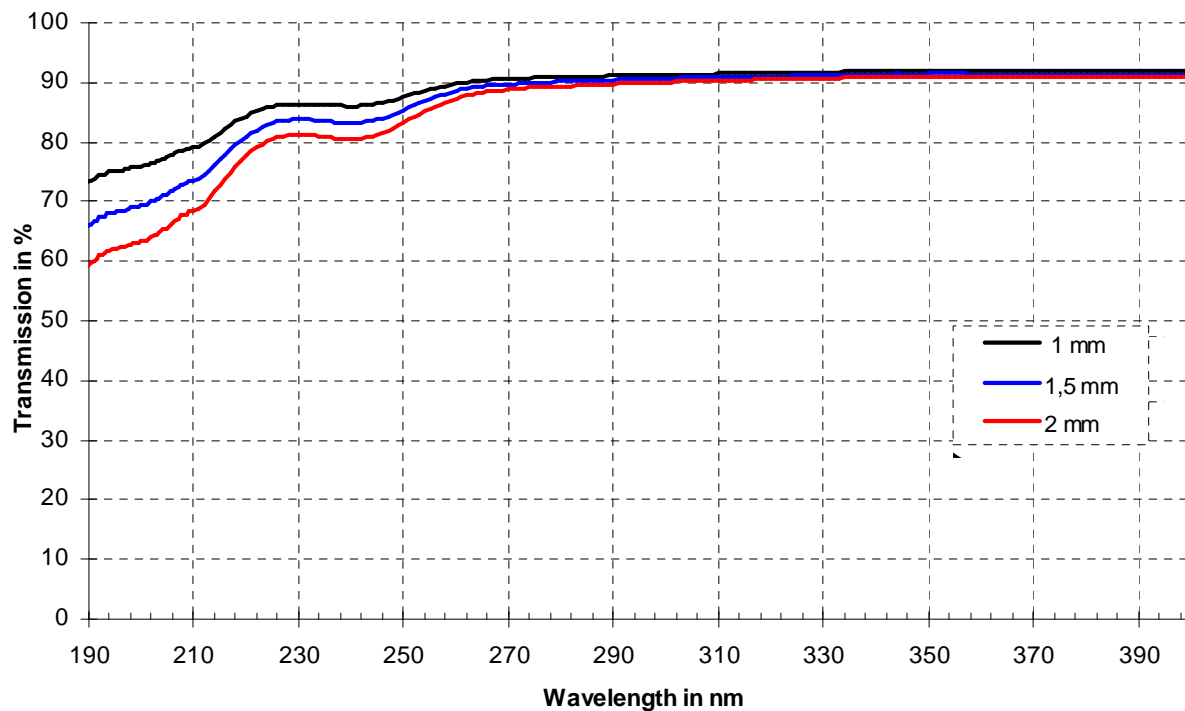
## 1 Optical Properties

### 1.1 Transmission

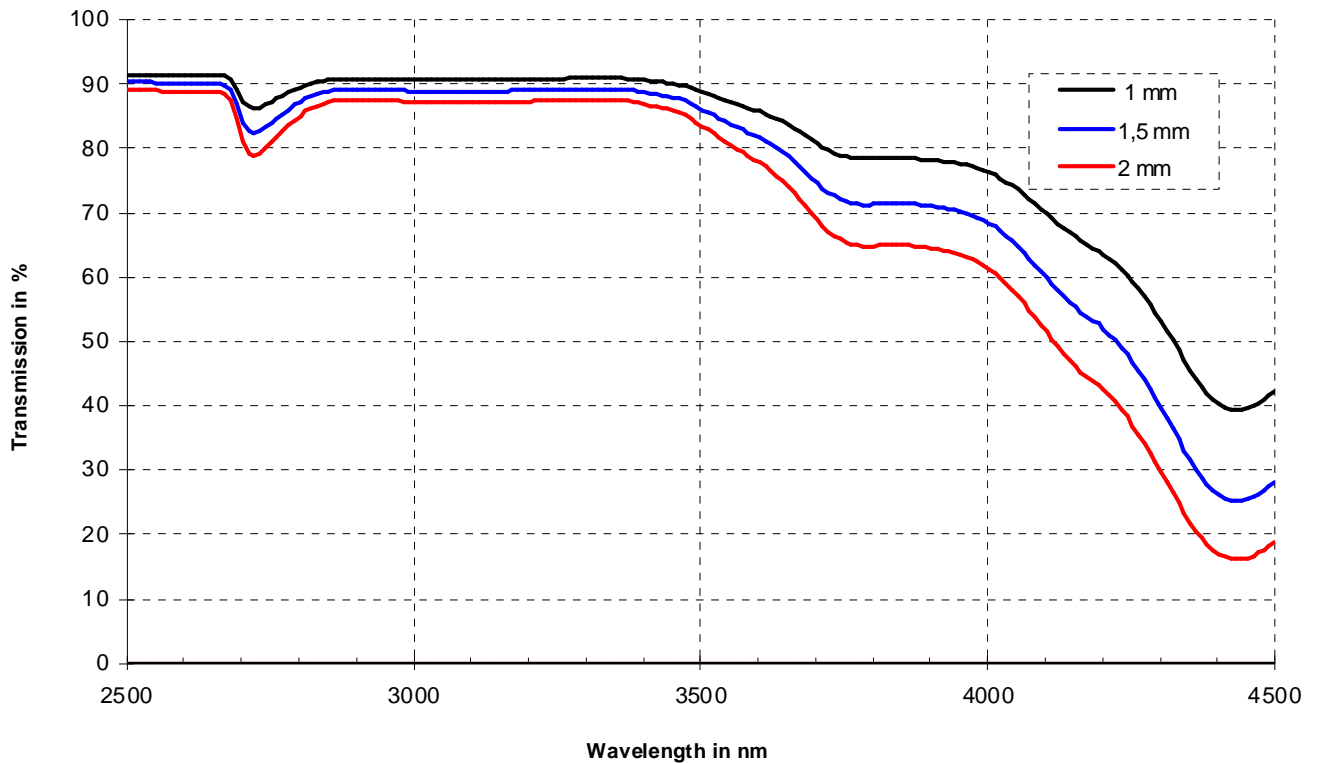
#### 1.1.1 Guaranteed values

Wavelength $\lambda$ [nm]	200	250	254	360	400
wallthickness 1 mm	70 %	85 %	87 %	90 %	91 %
wallthickness 1,5 mm	65 %	84 %	85 %	90 %	91 %
wallthickness 2 mm	55 %	82 %	84 %	90 %	91 %

#### 1.1.2 Typical Transmission for UV-range



### 1.1.3 Typical Transmission for IR – range



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

## 2 Hydroxyl Content (OH-content)

Definition: degree of hydroxyl groups in the tube wall (excluding outer surface)  
 The typical content in ilmasil PN fused quartz tubes is 30 ppm

Limit: max. 45 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.

### 3 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	> 10		0	20 mm
	> 5 – 10	max. 0.2	2	
	> 4 – 5	max. 0.2	3	
	> 2 – 4	max. 0.2	10	
	> 1 – 2	max. 0.2	15	not specified
	> 0,5 – 1	max. 0.2	35	
OD ≤ 40 mm; Wt > 1 – 2 mm	> 10		0	20 mm
	> 5 – 10	max. 0.2	2	
	> 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 > 2 -4 mm	> 10		0	40 mm
	> 5 – 10	max. 0.2	2	
	> 4 – 5	max. 0.2	5	
	> 2 – 4	max. 0.2	15	
	> 1 – 2	max. 0.2	30	not specified
	> 0,5 – 1	max. 0.2	80	



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**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 - OD < 40 mm with wt >4 mm	> 10		0		30 mm
	> 5 – 10	max. 0.2	2	15	
	> 4 – 5	max. 0.2	5		
	> 2 – 4	max. 0.2	10		
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: judge the whole cluster to the limits of a single bubble					

Inspection: visual, scale magnifier

Open Bubbles

Definition: A void, open to the outer or inner surface

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

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### 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: $OD * \Pi$ not permitted if completely circumferential
Inspection:	visual, caliper, scale magnifier

#### 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

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### 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

### 3.4.6 Bubble Scars

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

Limit: permitted if not 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**