Ilmasil™ PN 350
Clear fused quartz tubes

Product standard and inspection criteria

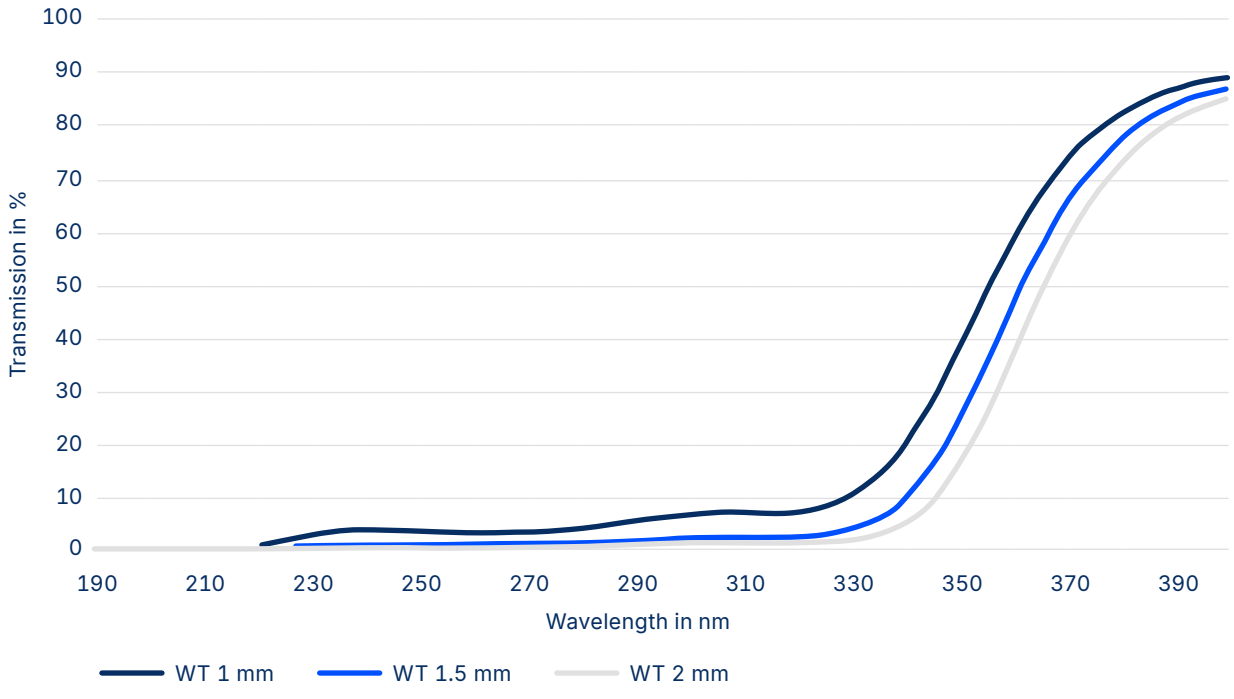
Application
This standard is applicable to direct drawn tubes produced with Ilmasil™ PN 350 base material

Optical properties

Transmission
Guaranteed values

Wavelength λ (nm)	220	250	340	360	400
Wall thickness 1 mm	0 %	< 5 %	< 3 %	< 25 %	> 50 %
Wall thickness 1.5 mm	0 %	< 1 %	0 %	< 10 %	> 40 %
Wall thickness 2 mm	0 %	< 1 %	0 %	< 5 %	> 30 %

Typical transmission for UV-range



Comment: 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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Hydroxyl content (OH-content)

Definition: degree of hydroxyl groups in the tube wall (excluding outer surface).
The typical content in Ilmasil™ PN 350 fused quartz tubes is 35 ppm

Limit: max. 55 ppm

Comment: 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.

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.

Bubbles

Enclosed bubbles

Definition: a spherical void, wholly within the tube wall

Limit: according to the following table

Tube outer diameter (OD)

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	
	> 2 – 20		not specified	40
	> 1 – 2		10	not specified
	> 0.5 – 1		20	
OD ≤ 40 mm WT > 1 – 2 mm	> 20	max. 0.2	0	
	> 2 – 20		not specified	40
	> 1 – 2		10	not specified
	> 0.5 – 1		20	
OD ≤ 40 mm WT > 2 – 4 mm	> 20	max. 0.2	0	
	> 2 – 20		not specified	40
	> 1 – 2		10	not specified
	> 0.5 – 1		20	

Bubbles in width and length < 0.3 mm are not counted

Bubbles in width and length > 0.3 to 0.5 mm:
total bubble cross section: max. 40 mm^2 per 100 cm^3 (as per DIN 58927)

Bubble clusters:
not permitted for length > 20 mm – judge the whole cluster to the limits of a single bubble

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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	max. 0.2	0	
	> 2 – 20		not specified	50

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. 60 mm² per 100 cm³ (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

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

Inclusions

Definition: included foreign particles (spots), visible by color difference

Limit: inclusions > 0.3 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

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

Surface defects

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 * π
- not permitted if completely circumferential

Inspection: visual, caliper, scale magnifier

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Scuff

Definition: broad surface abrasion (groups of lines wider as 0.1 mm)

Limit:
- 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

Waterspots, fingerprints, cutter dust

Definition: removable surface deposits left by washing residue or finger touch

Limit: permitted to a minor degree

Inspection: visual

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

Limit: not permitted

Inspection: visual

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

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)

Surface adhesions

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

Limit: not permitted if any sharp edges

Inspection: visual, manually

ENGLISH 07/2026 kn

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