BOROFLOAT® & LiDAR systems

A Union of Inspiration & Quality

BOROFLOAT® 33 from Germany is the world's first floated borosilicate flat glass. It combines superior quality and excellent flatness with outstanding thermal, optical, chemical and mechanical features and these features make **BOROFLOAT® 33** a perfect specialty glass solution for LiDAR systems. The chemical composition and physical properties of **BOROFLOAT® 33** are in accordance with DIN ISO 3585 and DIN EN 1748 T1. **BOROFLOAT®** – Inspiration through Quality.

The sum of its properties is what makes it unique for LiDAR applications

Entrance windows

- Exceptional high transparency at LiDAR wavelength
- Superior mechanical strength with best mechanical testing results
- Outstanding thermal resistance
- Excellent coating performance
- Low specific weight

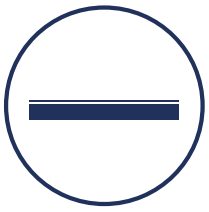
Mirrors / Filters

- Low color shift in VIS -Transmission
- Low Coefficient of Linear Thermal Expansion
- Excellent flatness due to unique Microfloat process
- UV bondable

At a glance

Excellent flatness

Exceptionally high transmission



Excellent coating performance

Superior mechanical strength

Outstanding thermal resistance

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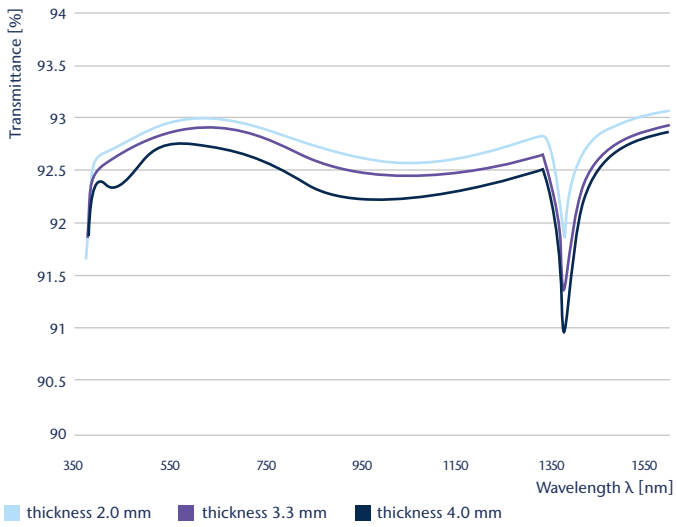
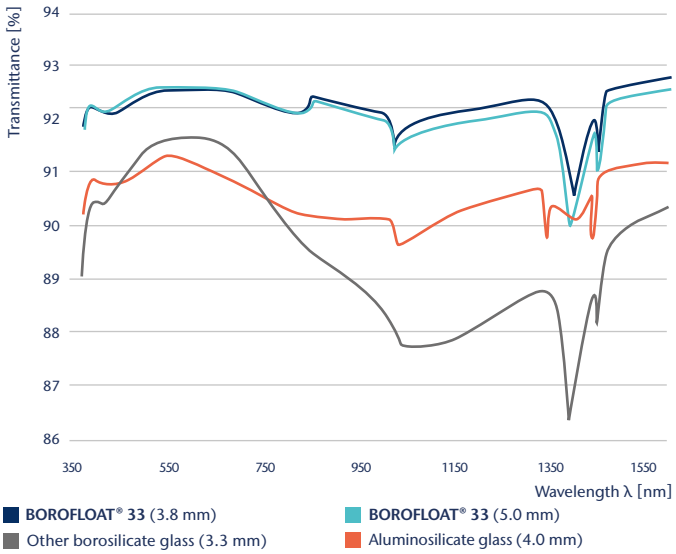
Optical properties of BOROFLOAT® 33 for LiDAR applications

Transmittance of BOROFLOAT® 33 at 350 – 1600 nm in different thicknesses



Exceptionally high transparency in visible and near IR range of wavelength. Inner transmittance (being not displayed in the diagram) is typically larger than 98% refering the most common laser wavelengths of LiDAR systems e.g. 905 nm or 1550 nm.

Transmittance of BOROFLOAT® 33 at 350 – 1600 nm in comparison with competition material

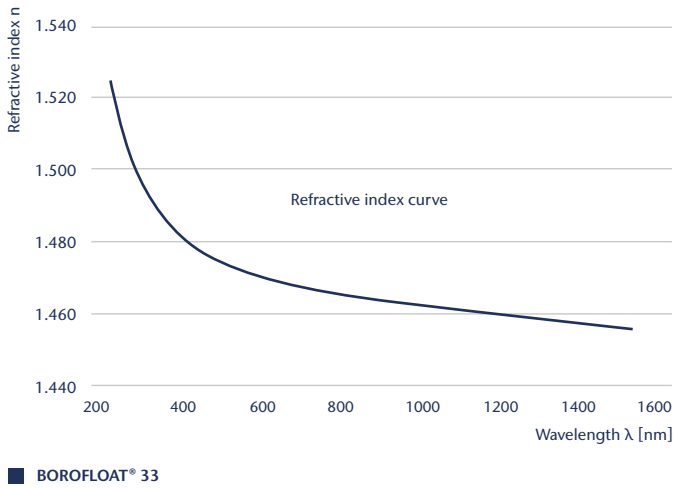


Better transparency at LiDAR wavelength (905 nm; 1550 nm) compared to competitive material. **BOROFLOAT® 33** in different thicknesses (3.8 and 5.0 mm) has up to 2% higher transmission than competitor's **borosilicate glass** material and significantly higher transmittance values compared to other glass types like aluminosilicate glass.

Dispersion

	$n_{248.3}$*	$n_{296.7}$	n_i	n_g	$n_{F'}$	n_e	n_d	$n_{632.8}$	$n_{C'}$	n_s	n_t	$n_{1529.6}$
λ	248.3	296.7	365.0	435.8	480.0	546.1	587.6	632.8	643.8	852.1	1014.0	1529.6
n	1.525	1.504	1.489	1.480	1.477	1.473	1.471	1.470	1.470	1.465	1.463	1.456

* calculated value done by extrapolation of the dispersion curve



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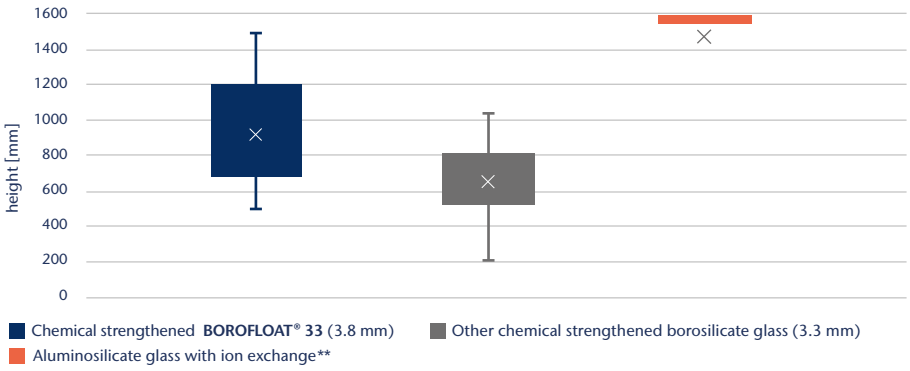
Mechanical properties and testing results

Protection windows for LiDAR devices require both – ball drop resistance as well as resistance to sharp impact. **BOROFLOAT®** combines a high resistance to dropped steel balls from certain heights and the resistance to stones that stress the glass surface. The low haze values of **BOROFLOAT®** shows indicate low light scattering compared to other glass types even if parts of the surface are showing slight impact patterns.

Resistance against impacts

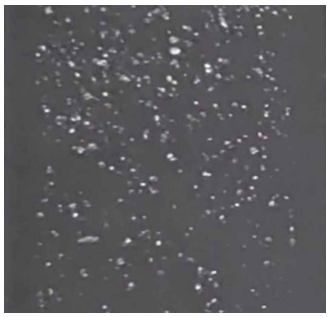
Ball drop tests



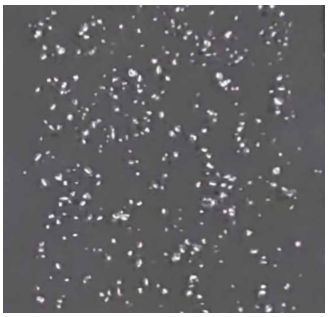
BOROFLOAT® withstands higher height ball drops with a 500 g steel ball when compared with other borosilicate glass. Please note: Samples with processed surface.

Resistance against stone impact

Gravel test *



Chemical strengthened **BOROFLOAT® 33**



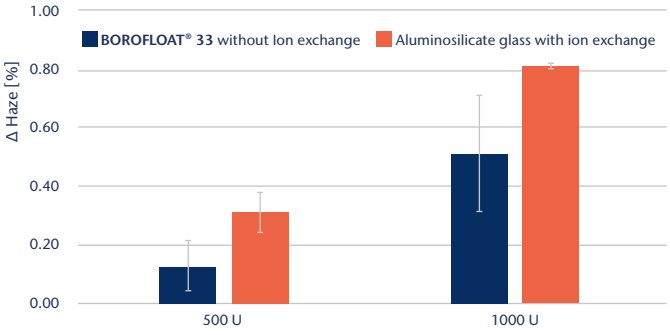
Aluminosilcate glass with ion exchange**

BOROFLOAT® shows better stone impact resistance than aluminosilicate glass with ion exchange.

* Tests carried out in accordance with DIN ISO 20567/ Test conditions: Erichsen 508 VDA, chilled-iron grit according to DIN EN ISO 11124-2; 2 x 500 g, Methode B: 2,0 ± 0,1 bar
** The chemical strengthening was made according to the specific glass type related typical standard protocols.

Resistance to abrasion

Haze after Taber Test



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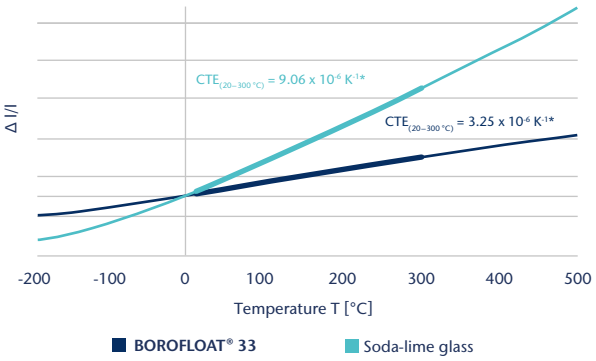
Thermal properties of BOROFLOAT® 33

Thermal properties

Specific heat capacity $c_{p\ (20–100\ °C)}$	0.83 kJ/(kg·K)
Thermal conductivity $\lambda_{\ (90\ °C)}$	1.2 W/(m·K)
Transformation temperature T_g* (according to ISO 7884)	525 °C

* Equivalent term: glass transition temperature.

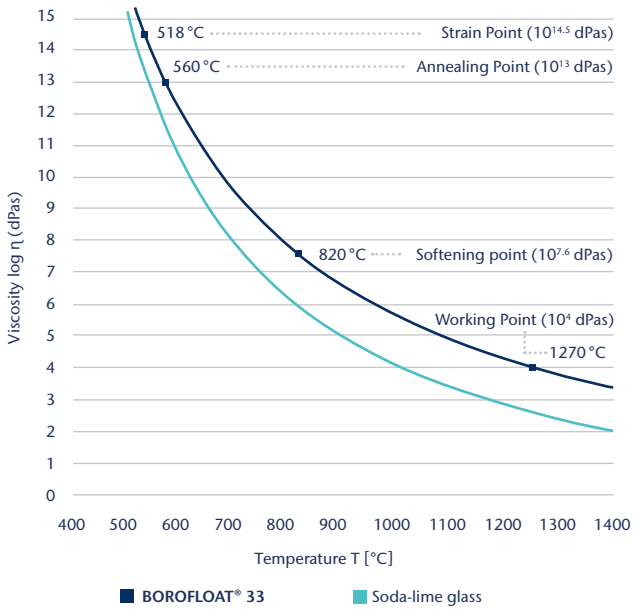
Coefficient of Linear Thermal Expansion (CTE)



* According to ISO 7991.

The CTE of **BOROFLOAT® 33** is 3 times lower than the CTE of soda-lime glass.

Viscosity of BOROFLOAT® 33



Resistance to thermal shock (RTS)

Glass thickness	RTS (5 %-fraktil)
≤ 3.8 mm	175 K
5.00 – 5.5 mm	160 K
6.5 mm	155 K
11 mm	142 K

Resistance to Thermal Shock (RTS) of **BOROFLOAT® 33**
The RTS value characterizes the ability of a glass panel to withstand a sudden temperature shock.

Panels measuring 20 x 20 cm (8 x 8 inches) are heated in an oven with circulating air and afterwards doused in the center with 50 ml of cold water (68 degree F). The temperature is controlled via pyrometer. The RTS value is the difference in temperature between the hot panel and the cold water, at which breakage occurs in less than or equal to 5% of the samples. In order to simulate damage that can occur in practical use, the samples are abraded with 220 grid sandpaper before testing.

Chemical properties of BOROFLOAT® 33

Chemical durability

Hydrolytic resistance	(according to ISO 719 / DIN 12 111)	HGB 1
	(according to ISO 720)	HGA 1
Acid resistance	(according to DIN 12 116)	1
	(according to ISO 1776) ≤ 100 µg Na_2O per 100 cm^2	
Alkali resistance	(according to ISO 695 / DIN 52 322)	A 2

All values listed on the data sheet are not guaranteed reference values.

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