
800
SCHOTT
DURAN
500

WHAT IS GLASS ?

Glass is an inorganic mixture fused at high temperature which solidifies on cooling but does not crystallize. Its basic components, network formers and modifiers, are present in the common glasses in the form of oxides.

Typical glass formers (network formers) are silicon dioxide (SiO_2), boric acid (B_2O_3), phosphoric acid (P_2O_5) and aluminium oxide ($Al2O_3$). These substances are capable of absorbing (dissolving) metal oxides up to a certain proportion without losing their glassy character. This means that the incorporated oxides are not involved in the formation of the glass but modify certain physical properties of the structure of the glass as "network modifiers".

A large number of chemical substances have the property that they solidify from the molten state into a glassy state. The formation of glass depends on its cooling rate and a necessary prerequisite is the existence of mixed types of bond (covalent bonds and ionic bonds) between the atoms or groups of atoms.

As a result, glass-forming products show a strong tendency whilst still in the molten state towards amorphous three-dimensional networking though polymerisation. Crystals are formed when the individual atoms form a regular three-dimensional arrangement in what is known as a "crystal lattice" as soon as the particular substance changes from the liquid to the solid state. Glass, however, forms a largely amorphous "network" when it cools down from the molten state. The components mainly involved in the formation of the glass are therefore described as "network formers". The glass-forming molecules in this network can incorporate ions that open up the network at certain points, changing its structure and thus the properties of the glass. They are therefore called "network modifiers".

WHAT IS DURAN® ?

The special features of DURAN®

Very high chemical resistance, nearly inert behaviour, a high usage temperature, minimal thermal expansion and the resultant high resistance to thermal shock are its most significant properties. This optimum physical and chemical performance makes DURAN® the ideal material for use in the laboratory and for the manufacture of chemical apparatus used in large-scale industrial plant. It is also widely used on an industrial scale in all other application areas in which extreme heat resistance, resistance to thermal shock, mechanical strength and exceptional chemical resistance are required.

Chemical composition of DURAN®

DURAN® has the following approximate composition:

81	% by weight	SiO_2
13	% by weight	B_2O_3
4	% by weight	Na_2O/K_2O
2	% by weight	Al_2O_3

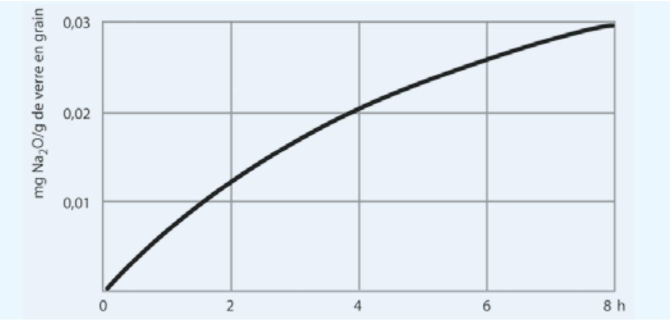
DURAN® properties are specified in DIN ISO 3585. In contrast to other borosilicate 3.3 glasses, DURAN® is notable for its highly consistent, technically reproducible quality.

Chemical properties

The chemical resistance especially of DURAN® glass is more comprehensive than that of all other known materials. DURAN® borosilicate glass is highly resistant to water, acids, saline solutions, organic substances and also halogens such as chlorine and bromine. Its resistance to alkali is also relatively good. Only hydrofluoric acid, concentrated phosphoric acid and strong alkalis cause appreciable surface removal of the glass (glass corrosion) at elevated temperatures (>100 °C). Due to the nearly inert behaviour, there are no interactions (e.g. ion exchange) between medium and glass and any spurious influence on experiments is thereby effectively excluded.

Hydrolytic resistance

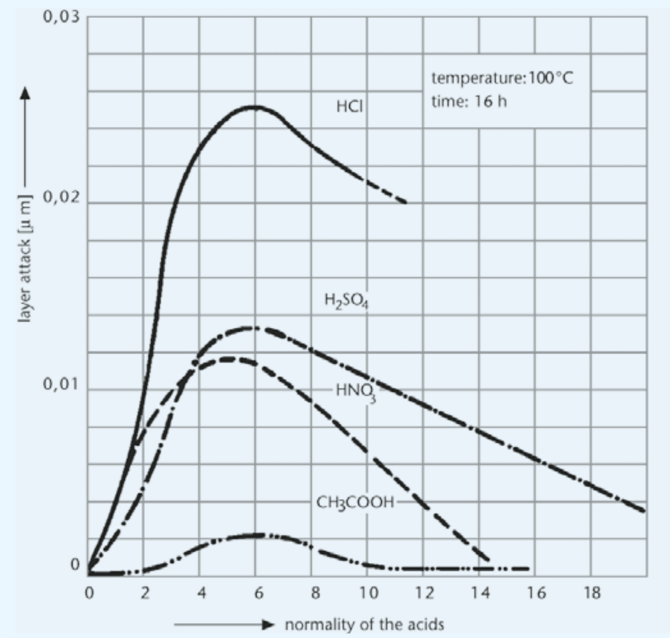
DURAN® corresponds to Class 1 of the glasses that are divided into a total of 5 hydrolytic resistance classes in accordance with ISO 719 (98 °C). The amount of Na_2O/g glass grain leached out after 1 hour in water at 98 °C is measured. For DURAN® the quantity of Na_2O leached out is less than 31 µg/g of glass grain. DURAN® also corresponds to Class 1 of the glasses divided into a total of 3 hydrolytic resistance classes in accordance with ISO 720: (121 °C). The quantity of Na_2O leached out after 1 hour in water at 121 °C is less than 62 µg/g of glass grain. Due to its good hydrolytic resistance, DURAN® meets the requirements of the USP, JP and EP for a neutral glass that corresponds to glass type 1. It can therefore be used in an almost unrestricted way in pharmaceutical applications and in contact with foodstuffs.



Hydrolytic attack on DURAN® as a function of time (100 °C)

Acid resistance

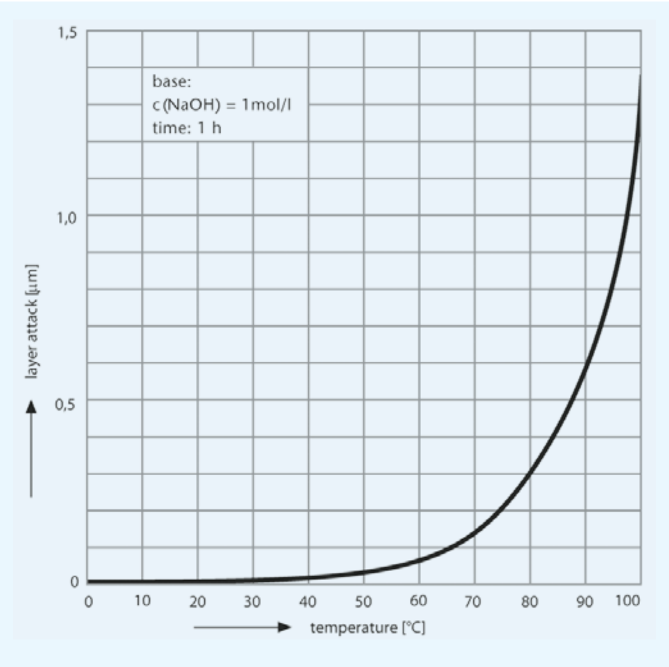
DURAN® corresponds to Class 1 of the glasses divided into 4 acid classes in accordance with DIN 12116. As the surface removal after boiling for 6 hours in normal HCl is less than 0.7 mg/100 cm², DURAN® is classed as acid-resistant borosilicate glass. The quantity of alkaline metal oxides leached out in accordance with ISO 1776 is less than 100 µg Na_2O/100 cm².



Acid attack on DURAN® as a function of acid concentration

Alkali resistance

DURAN® corresponds to Class 2 of the glasses divided into 3 alkali classes in accordance with DIN ISO 695. The surface erosion after 3 hours boiling in a mixture of equal volume fractions of sodium hydroxide solution (concentration 1 mol/l) and sodium carbonate solution (concentration 0.5 mol/l) is only 134 mg/100 cm².



Alkali attack on DURAN® as a function of temperature

Overview of the chemical properties of technical glasses

Description	Chemical resistance class		
	Hydrolytic resistance DIN ISO 719	Acid resistance DIN 12 116	Alkali resistance ISO 695
DURAN®	1	1	2
FIOLAX®	1	1	2
Soda-lime glass	3	1	2
SBW	1	1	1

Physical properties

Temperature resistance when heated and thermal shock resistance

The maximum permissible operating temperature for DURAN® is 500 °C. Above a temperature of 525 °C the glass begins to soften and above a temperature of 860 °C it changes to the liquid state. As it has a very low coefficient of linear expansion (α= 3.3 x 10^{-6} K^{-1}), a feature of DURAN® is its high thermal shock resistance up to ΔT = 100 K. For a temperature change of 1K, the glass changes by only 3.3 x 10^{-6} relative length units, resulting in low levels of mechanical strain were a thermal gradient exists. The thermal shock resistance is influenced wall thickness and product geometry.

Temperature resistance at low temperatures

DURAN® can be cooled down to the maximum possible negative temperature and is therefore suitable for use with liquid nitrogen (approx. – 196°C). During such use/ freezing In general DURAN® products are recommended for use down to – 70 °C.

When working at low temperatures, the effect of any expansion of a DURAN® vessel's contents must be borne in mind. During cooling and thawing ensure that the temperature difference does not exceed 100 K. In practice, therefore, stepwise cooling and heating are recommended. When freezing substances in such items as DURAN® bottles or DURAN® test tubes, the container should only be filled to a maximum of 3/4 of its capacity. Moreover, it should be frozen slanted at an angle of 45 ° (to enlarge the surface area). The minimum service temperature is dependant upon the properties of any screw caps or other components used. For the blue PP screw cap the minimum temperature is – 40 °C.

Use in the microwave

DURAN® laboratory glassware is suitable for use in microwaves. This also applies to plastic coated DURAN® products .

Overview of the physical properties of technical glasses

Description	Linear expansion coefficient α (20°C/300°C) [$10^{-6}K^{-1}$]	Transformation temperature [°C]	Density [g/ cm^3]
DURAN®	3.3	525	2.23
FIOLAX®	4.9	565	2.34
Soda-lime glass	9.1	525	2.5
SBW	6.5	555	2.45

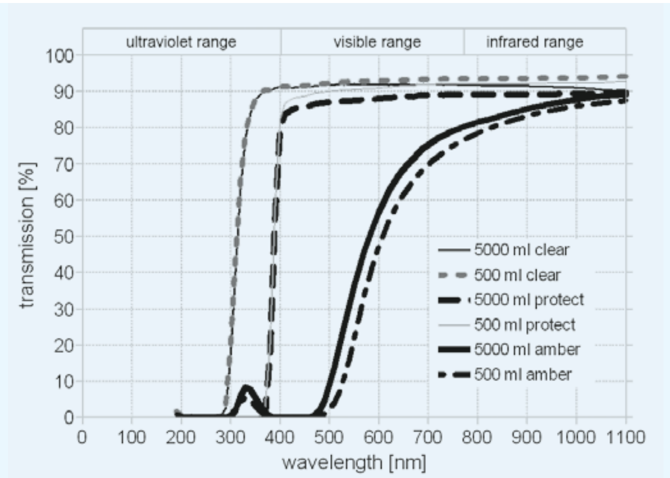
Optical properties

In the spectral range from about 310 to 2200 nm the absorption of DURAN® is negligibly low. It is clear and colourless. Fairly large layer thicknesses (axial view through pipes) appear slightly yellow/greenish. Amber-coloured DURAN® products are suited to use with light-sensitive substances (see amber colouring of DURAN®). This results in strong absorption in the short-wave region up to approx. 500 nm. In photochemical processes the light transmission of DURAN® in the ultraviolet range is of particular importance. The degree of light transmission in the UV range indicates the ease with which photochemical reactions can be carried out, for example chlorinations and sulfochlorination. The chlorine molecule absorbs light in the range from 280 to 400 nm and thus serves as a transmitter of the radiation energy.

Amber colouring of DURAN® laboratory glassware

Amber colouring enables storage of light sensitive substances in DURAN® products. Light transmission in the wavelength range between 300 and 500 nm is, in comparison with DURAN® clear glass, < 10%. Accordingly amber DURAN® glass corresponds to USP/EP/JP specifications.

To colour an existing piece of DURAN® glassware,it is sprayed using an innovative process with a special medium-diffusion ink solely on the outside of the clear glass. The piece is heated to a high temperature which mobilises the diffusing ions into the out layer of glass. On cooling, the ambering is very uniform, resistant to chemicals and cleaning in a dishwasher. The proven DURAN® properties within the bottle remain unaffected; there is no contact or interaction between contents and amber coating. The uniformity of the amber colouring process and the resultant quality of the amber colour is ensured by continuous monitoring.



Transmission curves for DURAN®

CONFORMITY WITH STANDARDS AND GUIDELINES

Alongside the international standard DIN ISO 3585, in which the properties of borosilicate glass 3.3 are defined, DURAN® laboratory glassware corresponds to the current standards for glass laboratory apparatus. The relevant DIN/ISO standards are given on the product pages of this catalogue. If the standard is changed, e.g. in case of harmonisation to ISO, our dimensions are adjusted accordingly within an appropriate time interval.

DURAN® is a neutral glass of high hydrolytic resistance and thus belongs to glass type 1 in accordance with the European pharmacopeia (EP, chapter 3.2.1), the Japanese pharmacopeia (JP, chapter 7.01) and the United States pharmacopeia (USP, section: 660) and National Formulary.