Glass and solar radiation

Technical Information about Glass

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Solar radiation

Components of solar radiation

The solar radiation that reaches the earth consists of 3% ultra-violet rays (UV), 55% infra-red radiation (IR) and 42% visible light.

These three components of solar radiation each correspond to a range of wavelengths.

Ultra-violet extends from 0.28 to 0.38 µm (nanometres)*, visible light from 0.38 to 0.78 µm and infra-red from 0.78 to 2.5 µm. The overall energy distribution of solar radiation, as a function of the wavelength between 0.3 and 2.5 µm (spectrum), for a surface perpendicular to this radiation, is represented by the curve shown below. This spectrum draws on definitions provided in BS EN 410 and certain atmospheric constants concerning the characterisation of the air and the diffused radiation.

Visible light

Visible light, or daylight, is the range of wavelengths of the electromagnetic spectrum between 0.38 µm and

0.78 µm.

The combined wavelengths of the visible spectrum when acting on the eye, result in the physiological effect known as vision.

Spectrophotometric characteristics

Radiation

When solar radiation strikes glass, it is partly reflected, partly absorbed in the thickness of the glass and partly transmitted.

The ratio of each of these 3 parts to the incident solar radiation defines the reflectance factor, the absorptance factor and the transmittance factor of the glazing.

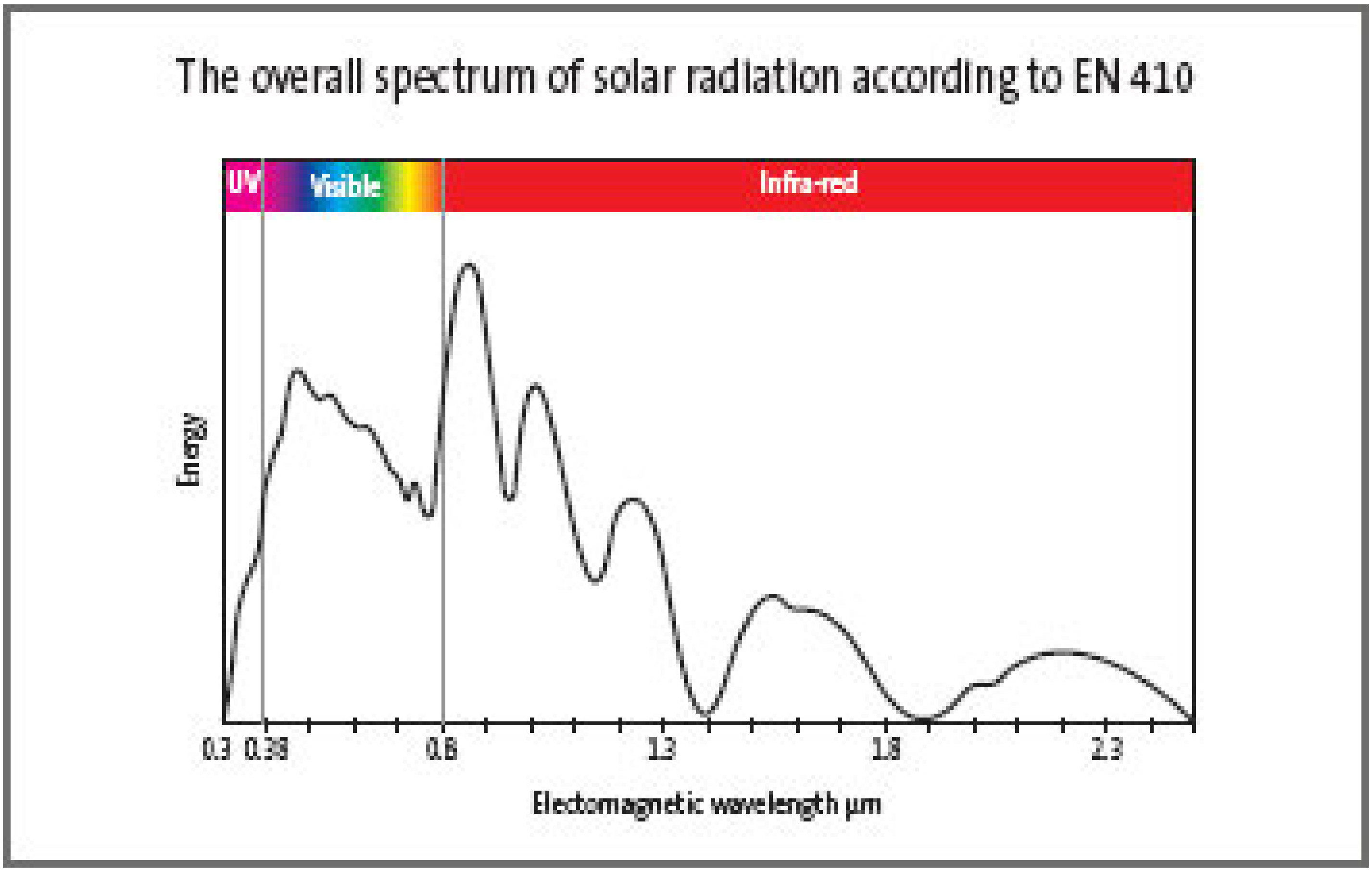
If these ratios are plotted for the electromagnetic spectrum, they form the spectral curve of the glazing.

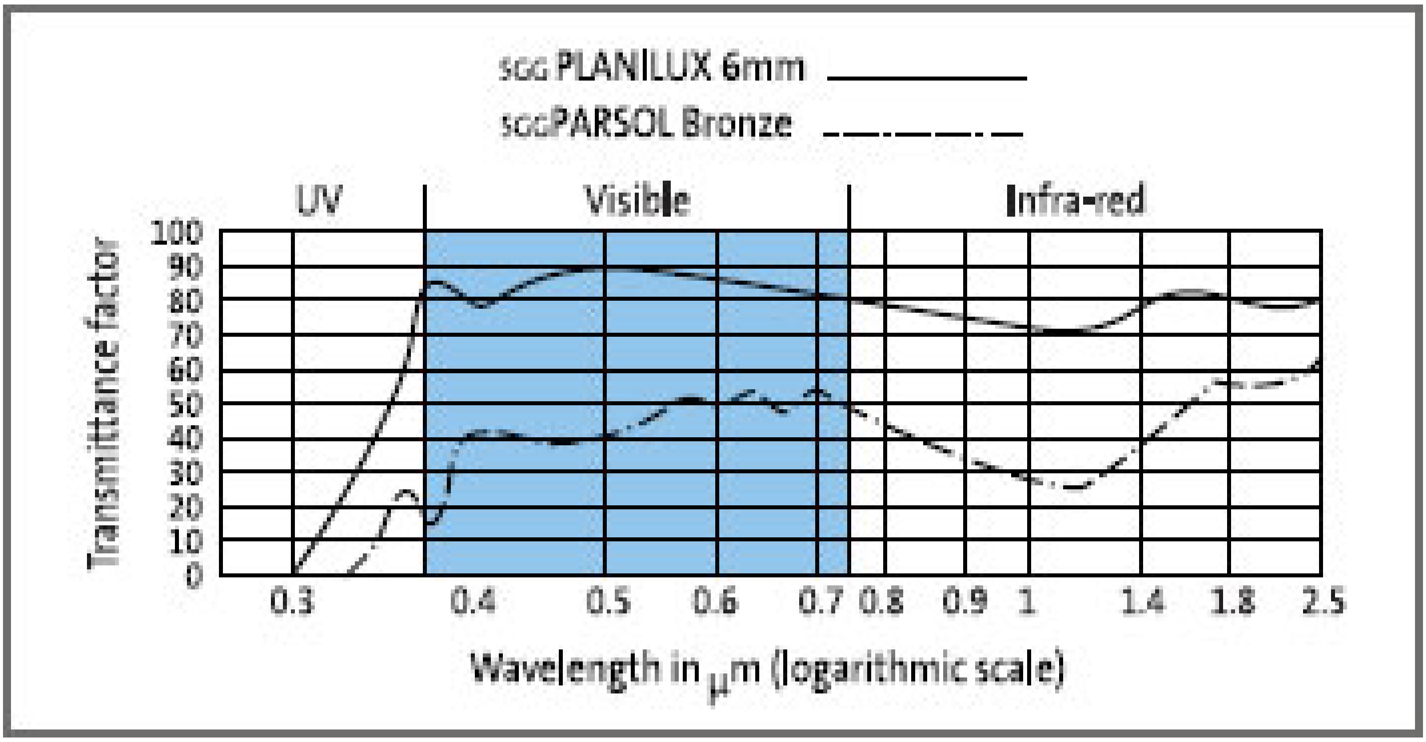
Factors which will affect these ratios for a given incidence, are the tint of the glass, its thickness and, in the case of a coated glass, the nature of the coating.

For illustration purposes, spectral transmittance curves are shown below for:

- SGG PLANICLEAR 6mm clear float glass

- SGG PARSOL Bronze 6mm body-tinted glass.





Transmittance, reflectance and absorptance factors

The transmittance, reflectance and absorptance factors are the ratios of the transmitted, reflected or absorbed radiant flux to the incident radiant flux.

The tables above give these three factors by glazing type, calculated in accordance with BS EN 410.

They are shown for wavelengths between 0.3 and 2.5 µm.

Light transmittance and light reflectance factors

The light transmittance and light reflectance factors are the ratios of the transmitted or reflected light flux to the incident light flux.

The tables above give these two factors by glazing type for natural light at normal incidence; these factors are given for comparison purposes, since slight variations may occur during manufacture.

Glass has an inherent green tint, which may be apparent in certain very thick or multiple glass constructions (in double-glazed and laminated form). This will vary with the overall thickness of the glazing or its constituents.

Solar factor or total transmittance

The solar factor (TT/SF/g) of glazing is the percentage of the total solar radiant heat energy entering the room through the glass.

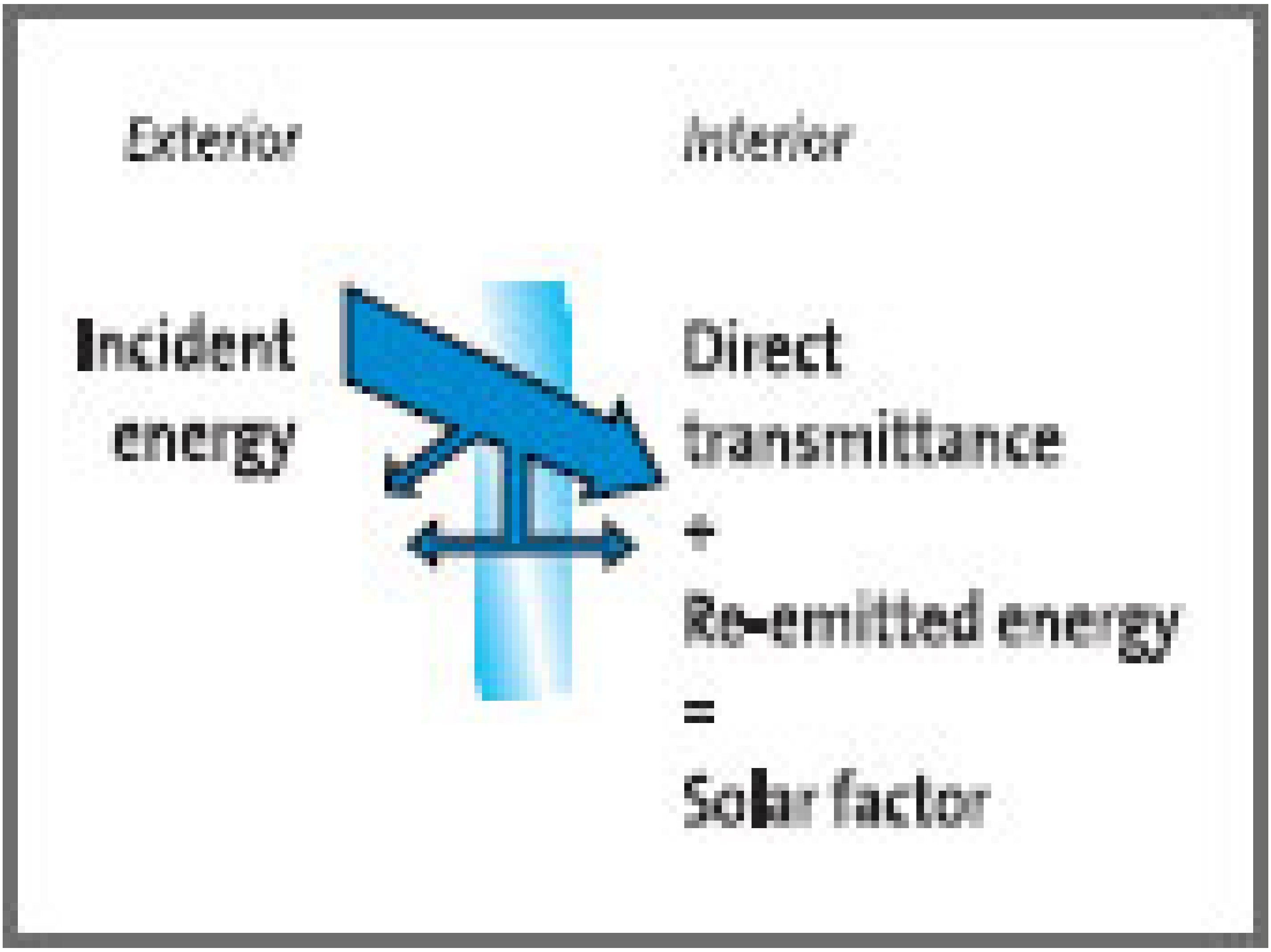
It is the sum of the solar radiant heat energy entering by direct transmittance and the proportion of the energy absorbed and re-emitted by the glazing to the interior space.

The performance tables above give the solar factors for the different types of glazing in accordance with EN

410 assuming the following points:

- the solar spectrum is as defined in the standard
- the internal and external temperatures are equal
- the exchange coefficients of the glazing to be 23 W/(m2.K) outwards and 8 W/(m2.K) inwards

See Thermal Insulation Glazing



Solar energy

Greenhouse effect

Solar radiant energy entering a room through the glass is absorbed by interior objects and surfaces, which then retransmit the energy as thermal radiation, see Thermal Insulation Glazing mainly in the far infra-red band (above 5 µm).

Even ordinary float glass is practically opaque to radiation with a wavelength higher than 5 µm.

This means that solar energy entering through the glass is trapped in the room, which then tends to heat up and is referred to as the “greenhouse effect”.

Solar control glazing

There are three major considerations regarding solar control glazing :

- the reduction of solar energy heat gain to achieve the lowest possible solar factor
- the control of heat transfer from the outside to the interior by means of the lowest U-value possible
- to achieve a good level of natural daylight through the highest light transmittance value possible.

SAINT-GOBAIN GLASS offers a comprehensive range of solar control glasses, providing varying performance and appearance options for individual applications.

Performance comparison for various double-glazed unit combinations

		LT (%)	U-value(1) (W/m²K)	Solar factor g
SGG COOL-LITE SKN 174 I SGG PLANILUX	6 mm 4 mm	68	1.1	0.41
SGG COOL-LITE KN169 SGG PLANILUX	6 mm 6 mm	61	1.3	0.44
SGG COOL-LITE SKN165 SGG PLANILUX	6 mm 6 mm	60	1.1	0.33
SGG COOL-LITE ST150 SGG PLANITHERM TOTAL	6 mm 6 mm	44	1.2	0.37
SGG ANTELIO SILVER (face 1) SGG PLANITHERM TOTAL	6 mm 6 mm	58	1.2	0.48

(1) Values give for a 15 or 16mm cavity filled with 90% argon.

For further information on the products, please refer to Section 2 The SAINT-GOBAIN GLASS product range

Solar control

To help reduce overheating the following steps can be taken:

- ensure adequate ventilation
- use blinds (ensuring they do not increase the risk of thermal breakage). Interior blinds are less effective since they only screen solar radiation which has already passed through the glass. If external blinds are

used, consideration for maintenance must be taken into account
- use low energy transmittance glazing, known as "solar control glass". This glass allows only a specified fraction of solar radiation energy to pass through, providing illumination but helping to prevent overheating.

Natural light

Daylight factor

Knowing the light transmittance factor of a particular glass makes it possible to assess the level of available light inside a room, when the exterior light level is also known. The ratio of the internal light level at a given point in a room to the exterior light level measured on a horizontal plane is constant, regardless of the time of day.

The ratio of internal light levels to external light levels is referred to as the "daylight factor" and is usually expressed as a percentage.

For example, a room with a daylight factor of 0.10 close to the glazing and 0.01 towards the back of the room (average figures for a typical room), an exterior light level of 5000 lux (overcast, thick clouds) provides an interior light level of 500 lux near the window and 50 lux at the back.

For the same room, a light level of 20000 lux (open sky, white clouds) produces light levels of 2000 and 200 lux respectively.

Comfortable light levels

The overall light level in a room is a major determinant to the feeling of well-being by ensuring optimum conditions and comfort for the eyes.

This is affected by the amount and distribution of light, the presence of glare and of any strong shadows.

The degree of comfort attained by natural light levels is determined by the light transmittance of the glass and is dependent on the overall light distribution, the orientation of the building and the size of the glazed area.

The fading effect

In certain circumstances, the colours of some materials can fade when exposed to direct sunlight.

As previously discussed, energy from the sun consists of three types of radiation:

- ultra-violet rays (UV), ranging from 0.28 to 0.38 µm. It is this part of the electromagnetic spectrum that causes sunburn,
- visible radiation or daylight, composed of a narrow band of the electromagnetic spectrum with wavelengths in the range 0.38 µm (violet) to 0.78 µm (red). The combination of these wavelengths produces white light,
- infra-red radiation (IR), which we feel as heat, is in the range 0.78 to 2.5 µm

Materials can change colour when exposed to solar radiation because the molecular bonds in the colouring agents are gradually weakened by high energy photons. This kind of photochemical reaction is mainly caused by ultra-violet radiation, though to a lesser extent it can also be due to short wavelength visible light (violet, blue).

When materials absorb solar radiation their temperatures rise, and this can also start chemical reactions that damage colours.

Generally colour fading is associated more commonly with organic colouring agents, in which the chemical bonds can be less stable than in mineral-based pigments.

Since all forms of radiation carry energy, objects cannot be completely protected from fading. Precautions can be taken, however, to minimise the problem, such as keeping them out of direct light, at low temperature and shielded from the atmosphere, especially from corrosive gases.

However, there are glass products which can provide effective solutions.

The most efficient way of preventing fading is to exclude ultra-violet radiation, since despite its low proportion within the electromagnetic spectrum, it is the main contributory factor to the process.

UV radiation can be virtually eliminated by the use of PVB laminated glass. Glasses from the SGG STADIP range can transmit only 0.4% of UV, compared to 44% for 10mm SGG PLANICLEAR glass.

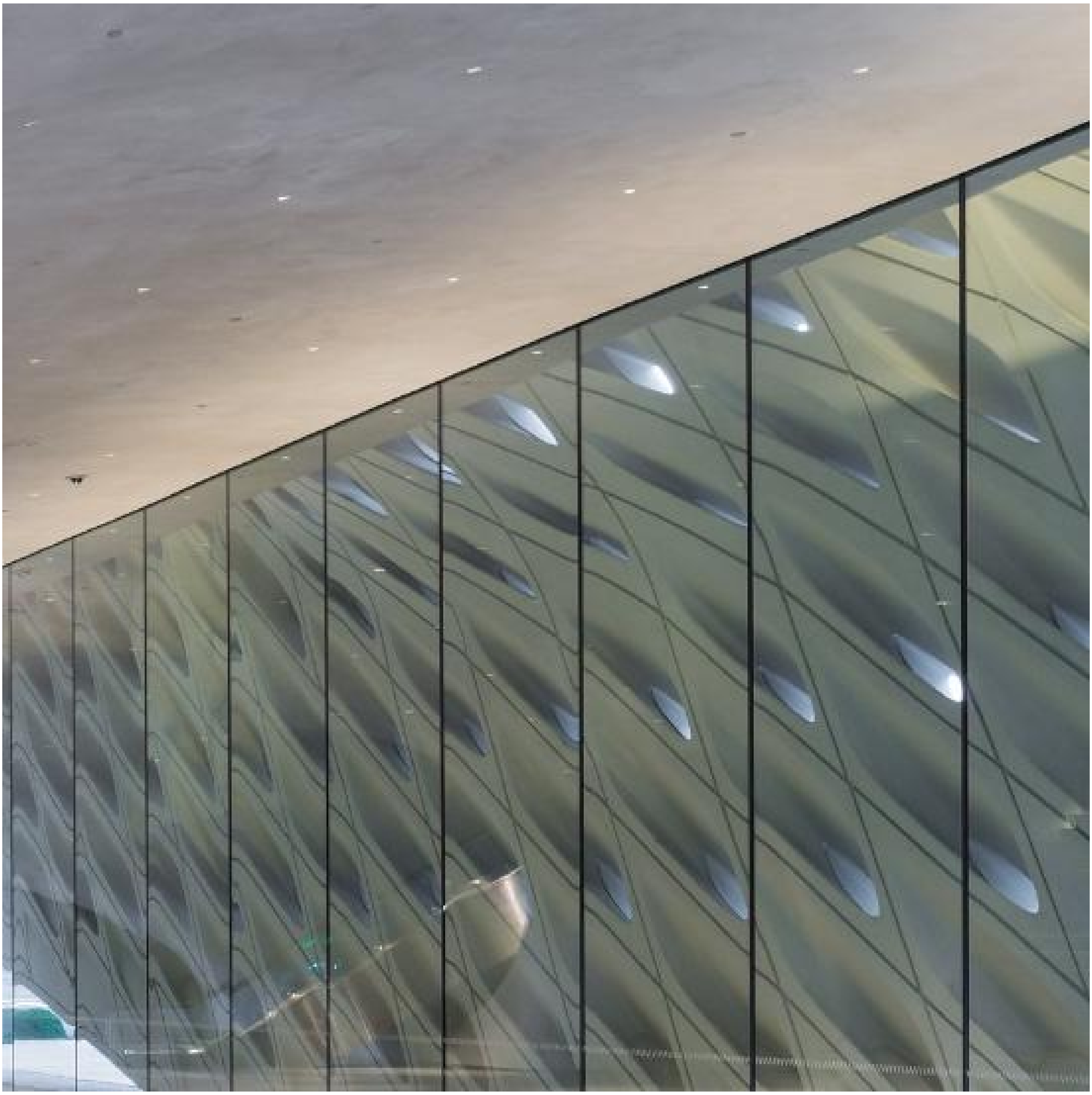
A second option is to use a body-tinted glass, which will filter light selectively: for example, yellow glass absorbs mainly violet and blue light. Thirdly, glass with a low solar factor could be used to reduce the thermal effect of the radiation.

It should be noted however, that no glass product can guarantee total protection from fading.

Optimising the performance of glazing must always involve a compromise between overall performance parameters and making a choice on grounds of aesthetics and economy.

Find out more

Determining the thickness of glass



Glass and thermal insulation


Safety & Protection

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