thereby producing coloured light or a reduction in the UV or IR range. Occasionally diffusing materials – e.g. opal glass or opal plastics – are used for front covers in order to reduce lamp luminance and help to control glare.

2.6.1.3 Absorption

Absorption describes how the light falling on a surface is totally or partially absorbed depending on the absorption factor of the given material.

In the construction of luminaires absorption is primarily used for shielding light sources; in this regard it is essential for visual comfort. In principle, absorption is, however, not wanted, since it does not control, but rather wastes light, thereby reducing the light output ratio of the luminaire. Typical absorbing elements on a luminaire are black multigrooved baffles, anti-dazzle cylinders, barn doors or louvres in various shapes and sizes.

2.6.1.4 Refraction

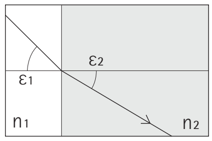
When beams of light enter a clear transmitting medium of differing density – from air into glass and vice versa from glass into the air, for example – it is refracted, i.e. the direction of its path is changed. In the case of objects with parallel surfaces there is only a parallel light shift, whereas prisms and lenses give rise to optical effects ranging from change of radiation angle to the concentration or diffusion of light to the creation of optical images. In the construction of luminaires refracting elements such as prisms or lenses are frequently used in combination with reflectors to control the light.

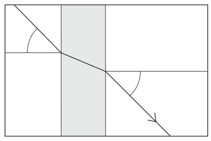
2.6.1.5 Interference

Interference is described as the intensification or attenuation of light when waves are superimposed. From the lighting point of view inteference effects are exploited when light falls on extremely thin layers that lead to specific frequency ranges being reflected and others being transmitted. By arranging the sequence of thin layers of metal vapour according to defined thicknesses and densities, selective reflectance can be produced for specific frequency ranges. The result can be that visible light is reflected and infrared radiation transmitted, for example – as is the case with cool-beam lamps. Reflectors and filters designed to produce coloured light can be manufactured using this technique. Interference filters, so-called dichroic filters, have a high transmission factor and produce particularly distinct separation of reflected and transmitted spectral ranges.

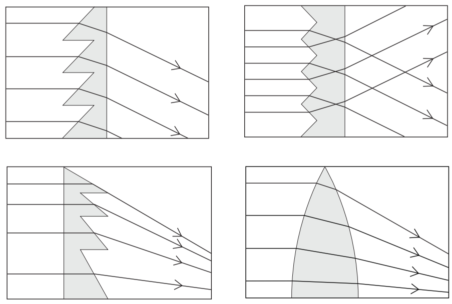
When transmitted from one medium with a refractive index of n_1 into a denser medium with a refractive index of n_2 rays of light are diffracted towards the axis of incidence ($\varepsilon_1 > \varepsilon_2$). For the transition from air to glass the refractive index is approx. $n_2 / n_1 = 1.5$.

$$\frac{\sin \varepsilon_1}{\sin \varepsilon_2} = \frac{n_2}{n_1}$$



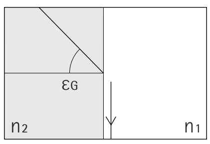


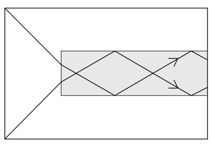
When transmitted through a medium of a different density, rays are displaced in parallel.



Typical ray tracing through an asymmetrical prismatic panel (top left), symmetrical ribbed panel (top right), Fresnel lens (bottom left) and collecting lens (bottom right).

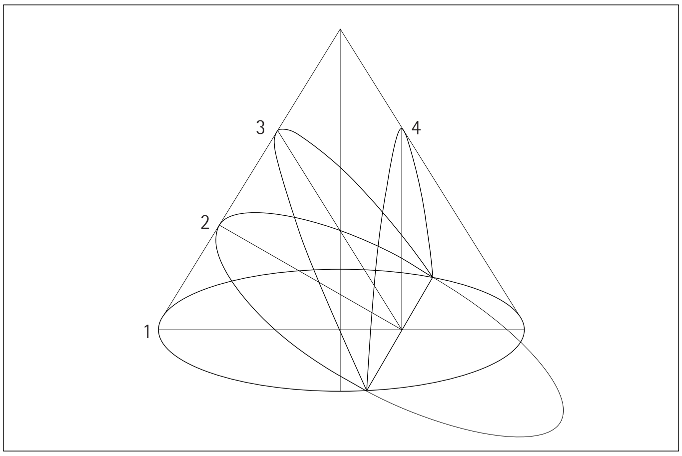
$$\sin \varepsilon_G = \frac{n_2}{n_1}$$

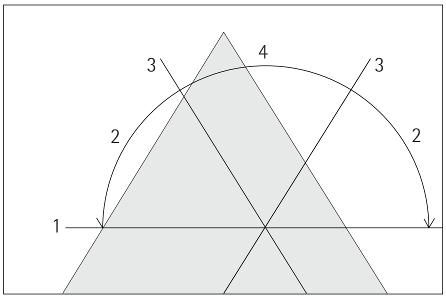


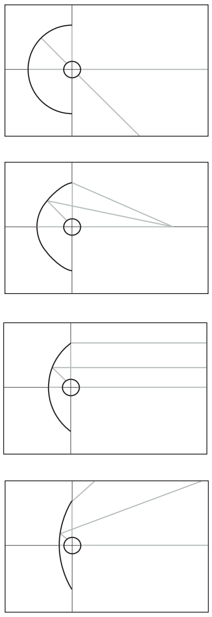


There is an angular limit ε_G for the transmission of a ray of light from a medium with a refractive index of n_2 into a medium of less density with a refractive index of n_1. If this critical angle is exceeded the ray of light is reflected into the denser medium (total reflection). For the transition from glass to air the angular limit is approx. ε_G = 42°. Light guides function according to the principle of total internal reflection (below).

Circle (1), ellipse (2), parabola (3) and hyperbola (4) as the sectional planes of a cone (above). Diagram of the sectional planes and sections (below).







Ray tracing from a point light source when reflecting on circle, ellipse, parabola and hyperbola (from top to bottom).

2.6.2 Reflectors

Reflectors are probably the most important elements in the construction of luminaires for controlling light. Both reflectors with diffusely reflecting surfaces – mostly white or with a matt finish – and highly specular surfaces are used. These reflectors were originally made of glass with a mirrored rear surface, which led to the term which is still used today: mirror reflector technology. Anodized aluminium or chrome or aluminium-coated plastic are generally used as reflector material today. Plastic reflectors are reasonably low-priced, but can only take a limited thermal load and are therefore not so robust as aluminium reflectors, whose highly resistant anodized coating provides mechanical protection and can be subjected to high temperatures.

Aluminium reflectors are available in a variety of qualities, ranging from high-quality super-purity aluminium to reflectors with only a coating of pure aluminium. The thickness of the final anodised coating depends on the application; for interior applications it is around 3–5 µm, for luminaires to be used in exterior spaces or chemically aggressive environments up to 10 µm. The anodising process can be applied to the aluminium coil (coil anodising) or on the finished reflectors (stationary anodising), which is more expensive.

The surfaces of the reflectors can have a specular or matt finish. The matt finish produces greater and more uniform reflector luminance. If the reflected light beam is to be slightly diffuse, be it to attain softer light or to balance out irregularities in the light distribution, the reflector surfaces may have a facetted or hammered finish. Metal reflectors may receive a dichroic coating, which can control light luminous colour or the UV or IR component.

Light distribution is determined to a large extent by the form of the reflector. Almost all reflector shapes can be attributed to the parabola, the circle or the ellipse.