

Reflectivity

How we see

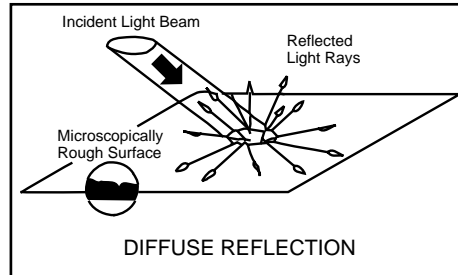
How well we see an object during the day is determined by the amount and color of the light it gives off compared to the amount of light given off by its surroundings. This light can be emitted by the object, or reflected from the object. Light emission is generated either by incandescence or luminescence. The light bulb and the firefly are examples. The light beams created by emission give the object visibility. In either case, emitted light is its own source, and consumes energy, even when no one is around to benefit from it, like an internally lighted sign or luminaire.

What is reflectivity?

Reflectivity, on the other hand, does not create its own light. It borrows light from another source. The borrowed light waves strike an object and “bounce” from it. The reflectance of the object—how bright it shines—depends on the intensity of the light striking it and the materials from which it is made.

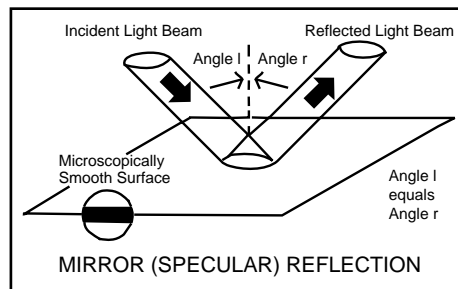
How the material reflects the light is important to nighttime driving. The three basic types of reflectivity—diffuse, mirror, and retroreflection—and the specific kinds of surfaces that cause them are described below.

Diffuse reflection is the most common type of reflectivity and occurs when light strikes rough surfaces, such as pavement, foliage, clothing, and vehicles. These surfaces cause the light beams to scatter in all directions. Only a small amount of the light is reflected back toward the source. Diffuse surfaces offer low nighttime visibility to drivers.

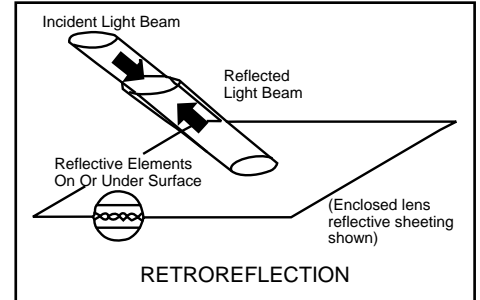


Mirror (specular) reflection occurs when light strikes surfaces that are smooth or glossy. The light reflects off the surfaces at an equal, but opposite angle to the source. If the surface is at an exact right angle to the vehicle, it will return the light to the source. But most mirror surfaces on the road will be at angles that reflect the light away from the drivers' eyes.

This specular phenomenon may be experienced at night when diffused surfaces, such as pavement, are covered with water or ice. Distant lights and on-coming headlights glance off the wet pavement, instead of scattering in all directions, and create glare for the on-coming driver.



Retroreflection occurs when surfaces return a portion of the directed light to its source. This is why retroreflective materials appear brightest to observers located near the light source—a driver and the vehicle headlights, for example. This is true for drivers at almost any viewing angle, which makes retroreflective surfaces excellent for night visibility.

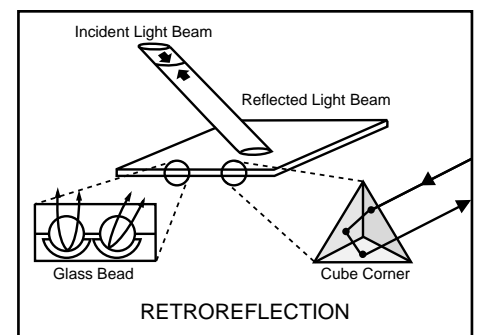


How retroreflection works

Basically, retroreflective sheeting uses tiny glass beads or cube corner elements to reflect light.

Spherical reflection

Each glass bead works this way: An incident (incoming) light beam refracts (bends) as it passes through the front surface of the glass bead and reflects off a mirrored surface behind the bead. The beam then passes back through the front surface, is refracted as it leaves the bead, and returns toward the light source.



Cube corner reflection

Like beads, cube corners are retroreflective lens elements. Each has three mutually perpendicular refractive surfaces. An incident light ray is refracted on each of the three surfaces and is returned to its source on

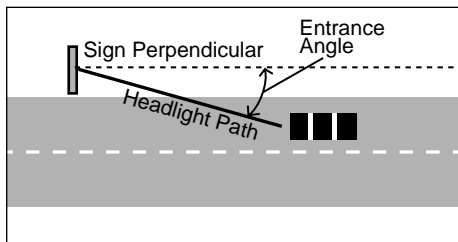
a parallel to its initial direction. It functions much as a ball bounced into the corner of a room.

The glass beads or cube corner elements are built into retroreflective sheeting and are protected by a smooth top film. There are several types of sheetings of differing construction and performance.

Retroreflective properties

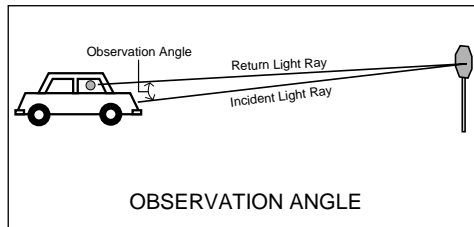
To fully appreciate how retroreflective materials can help make your roads safer at night, it is helpful to understand these terms: entrance angle, observation angle, cone of reflected light and retroreflectance.

Entrance angle is the angle formed between a light beam striking a surface at some point and a line perpendicular to the surface at the same point. This is the angle referred to when discussing the "angularity" of reflective sheeting. And it is especially important when you consider that signs are often positioned far off the shoulder, on the left hand side of the road, on curves, and can become misaligned due to accident or snowplow abuse.

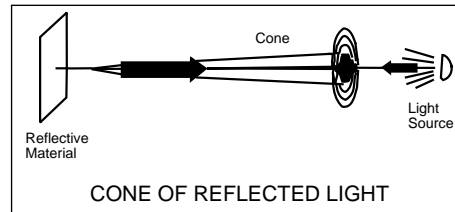


Observation angle is the angle between the line formed by a light beam striking a surface and the line formed by the retroreflected beam at the observer's eye.

Retroreflective materials direct incident light back to the source in a cone. Efficient retroreflective materials will include all observation angles to meet motorist needs.

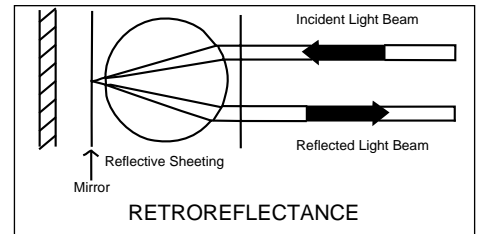


This **cone of retroreflective light** is very small, with virtually all of the reflected light within 3° of the source. This is not a problem for traffic signing since a driver is very near the headlights.



Retroreflectance is a term used to describe the amount of light reflected from a retroreflective material. This light is measured in candlepower (reflected) per foot candle (incident

light) per square foot (of reflected material). In the metric system, it is "candelas per lux per square meter."



Retroreflectance at specified entrance angles ($\sim 4^\circ$, $+30^\circ$, $+50^\circ$) and observation angles ($.2^\circ$, $.5^\circ$) are an important part of specifications for reflective sheeting to insure that driver needs are met consistently.

Luminance

The light that we observe from an illuminated or reflective surface gives us what is described as "luminance." Luminance is measured in units of foot lamberts, or the metric equivalent candelas/meter². So luminance is "what the motorist actually sees."

3M pioneered the development of retroreflective sheetings over 50 years ago and continues to be the leader in producing retroreflective sheetings to meet the challenges of today's roadways and drivers.