What is a Hot Mirror?

A hot mirror is in essence a thin film coating applied to substrates in effort to reflect infra-red radiation either as a means to harness the reflected wavelengths for an application or to remove them from an application.

Hot mirrors are often misunderstood due to their name and understandably so. Judging by the name it would be reasonable to believe that these kinds of coatings reflect heat by reflecting the infrared spectrum. Along that line of thought it would seem that objects illuminated by visible light passing through a hot mirror would be cold, however that is not entirely the case.

It's true that a hot mirror reflects a significant amount of heat through its effect on the infrared spectrum. There is still a measurable amount of heat generated through high-energy visible light photons. These shorter length visible light photons actually carry more energy than those in the IR band. This means that if you implement a hot mirror and measured the temperature of the illuminated subject, you would still see a rise in temperature, albeit less of one than if you were to forgo the use of the hot mirror.

So this shows us that it's not actually heat that they reflect, but the IR band and sometimes the UV band. As demonstrated by our HM-VS-1600 Hot Mirror which specifies that the average transmission is to be more than 85% from 425 to 675 nano-meters (nm) and the average reflectance is more than 90% from 750 to 1150 nm and 80% from 1150 to 1600 nm, but also indicates a high reflectance under 375 nm shown by the graph.

Another aspect of hot mirrors to be aware of is that most hot mirrors are colored a light yellow. This can adversely affect some applications that require the light to be as white as possible. For this reason ZC&R includes color neutral hot mirrors in our standard line.

What is a Cold Mirror Used For?

Referencing our recent post on hot mirrors can help greatly in understanding how a cold mirror functions as they are both heat control coatings.

Cold mirrors are much like hot mirrors in that they are used to separate IR from the non-IR. The major difference between the two is that cold mirrors transmit IR bands and reflect one or more non-IR bands. As can be seen in our UV Cold Mirror graph, the coating represented is specially designed to reflect more than 95% of UV rays from 350 to 450 nm while transmitting more than 90% between 550 and 1200 nm at 45 degrees angle of incidence. This means that you can use this coating to split a beam and have the longer bandwidths (550 to 1200nm) transmitted while UV rays (350 to 450 nm) are reflected and sent another route. This can help isolate bands that are needed for a particular application while unneeded or possibly harmful bands can be isolated and removed from the application.

One particularly useful application for this kind of dichroic filter we've discussed before is in reference to optical fiber. Optical fiber can be damaged by Ultra-Violet and Infra-Red radiation. When a cold mirror is used in conjunction with a hot mirror you can isolate application specific visible light from harmful UV and IR bandwidths such that the visible is transmitted to the optical fiber to be used and the UV/IR are reflected away from the fiber where they will not damage or harm the application.

Cold mirrors are often used in lighting applications where excess heat is not desired and IR radiation is not helpful. In these applications the visible light is reflected to the application and the IR is transmitted away from the application.

Protect Fiber-Optic Cable from UV and IR Damage with Hot and Cold Mirrors

How are hot mirrors and a cold mirrors used to prevent UV and IR radiation from damaging fiber-optic cable?

Recently we've been getting a few questions about the effects of UV and IR radiation on optical fiber that is often used in high speed local area fiber-optic communications equipment and image displays or lighting systems. So we thought it was about time we shared a basic synopsis of the effects and a few methods by which to prevent unwanted radiation from destroying costly equipment or delaying expensive projects.

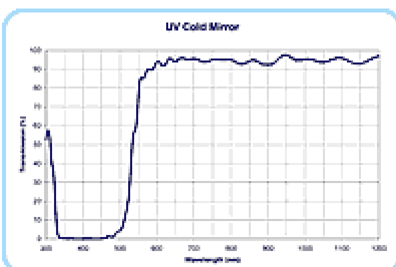
It's important to understand what optical fiber is. Optical fiber is made of either glass, plastic or polycrystalline materials such as quartz and is intended to carry visible or infrared light from one end of the fiber to the other. The optical fiber is coated with a transparent cladding to enhance the refractive index of the fiber and is then surrounded by a buffer and a jacket for mechanical protection. The optical fiber functions by having light emitted from a source, such as a high energy arc lamp, diode laser or LED, coupled into the core of the fiber, which contains and directs the light to the other end of the optical fiber where it can be read as data or displayed as an image.

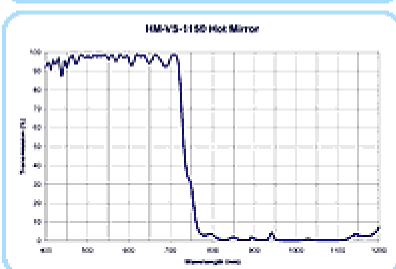
The various compositions of optical fiber have different strengths and weaknesses. For instance optical fiber used in long distance communication, such as those making up the backbones of the internet, are very likely composed of germanium dioxide doped silica glass, which has the benefit of a lower optical attenuation, but is often very expensive to implement when compared to Plastic optical fiber (POF) due to the special handling and installation techniques required.

Optical fiber has many practical applications from medical surgical headlamps to high end communications channels. For some industrial, medical or sensing applications where larger cores are needed than in standard data communications, a plastic-clad silica fiber or polymer-clad silica fiber (PCS) is used. Optical fiber is used in many different applications, many of which require that the light passing through the optical fiber be as bright as possible. This is often achieved through the use of high energy arc lamps.

The low cost of implementation for POF and PCS make them preferable to glass optical fiber in many different applications. One thing that makes them less preferable is their susceptibility to UV and IR radiation damage. The damage from high energy UV photons takes the form of solarization of the core and/or cladding which can discolor the fiber thus causing signal degradation. Solarization can form physical defects in the fiber which can selectively absorb the visible light spectrum which adversely affect the transmittance efficiency of the fiber. In extreme cases, the fiber core face can be burned, all but destroying the fiber's functionality.

Quartz and glass optical fibers have an advantage of being more resistant to the effects of UV and IR damage, but are not immune to the effects of high irradiance levels of UV light. While arc sources are the brightest, they are also the most damaging. However, even lower power sources can cause UV and IR damage. There are a few ways to effect the prevention of this damage, but one of the most effective is to use a combination of hot and cold mirrors.





Hot mirrors can be used to protect the fiber by reflecting the UV and IR wavelengths away from the fiber while transmitting visible light. This will allow most of the desired light to be used in the application while the harmful UV radiation is prevented from damaging the fiber. Cold mirrors can also be used to protect the optical fiber by reflecting the desired visible light to the fiber and passing the harmful IR wavelengths on to a disposal method. Even better than using just one of these mirrors is to use both, as each kind of mirror is not perfect, using them in conjunction with each-other allows for a greater degree of protection, while retaining the light needed for the application.

One way to achieve the use of a hot mirror and cold mirror is to set the cold mirror at a 45 degree angle to the light source such that the visible light is reflected toward the optical fiber and the IR wavelengths are passed through to an absorptive mechanism or a venting port. Then the hot mirror is placed between the cold mirror and the optical fiber so that the limited remaining harmful UV wavelengths are reflected away from the fiber.

Another method by which the hot mirror and cold mirror can be used is to coat the reflective backing of the light source with a combination coating, causing the IR and UV radiation to pass into the housing where it can be absorbed or vented.

For more information about Hot Mirror and Cold Mirror applications, please call ZC&R Coatings for Optics at 1-800-426-2864.

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