Infrared Window Material Choices

Manufacturers have used Infrared (IR) windows in motor control centers (MCC) and electric switchgear for over two decades. Here is a listing of some of the IR lens materials that are used:

- Arsenic Trisulfate
- Barium Fluoride
- Cadmium Telluride
- Calcium Fluoride
- Fused Silica
- Gallium Arsenide
- Germanium
- IR Polymer (Opaque)
- IR Polymer (Transparent)
- Lead Fluoride
- Lithium Fluoride
- Magnesium Fluoride
- Magnesium, Oxide
- Sapphire
- Sodium Chloride
- Silicon
- Thallium Bromo Iodide
- Zinc Selenide
- Zinc Sulfide

Each of the materials above has pluses and minuses when comparing one substance to another. Theselens materials act as a filter. In other words, each has their unique wavelengths allowing the IR energy to pass through. Besides the transmission range of each material there other factors to consider:

- Fragility
- Temperature range
- Hygroscopic
- Health hazards

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Fragility

Many of the crystals above are fragile. The larger the diameter, the more fragile the crystal is. Crystals are grown, cut into blanks, machined, and polished much like the lenses for eyeglasses. The lenses are handmade. We plan on about a 10% breakage factor when we order crystals from the manufacturer. We caution our customers that the crystals will break if placed under stress or dropped. Because they are fragile, when you have a crystal that breaks, you now have a hole the size of the lens diameter that can affect the electrical environment inside an enclosure.

Temperature Range

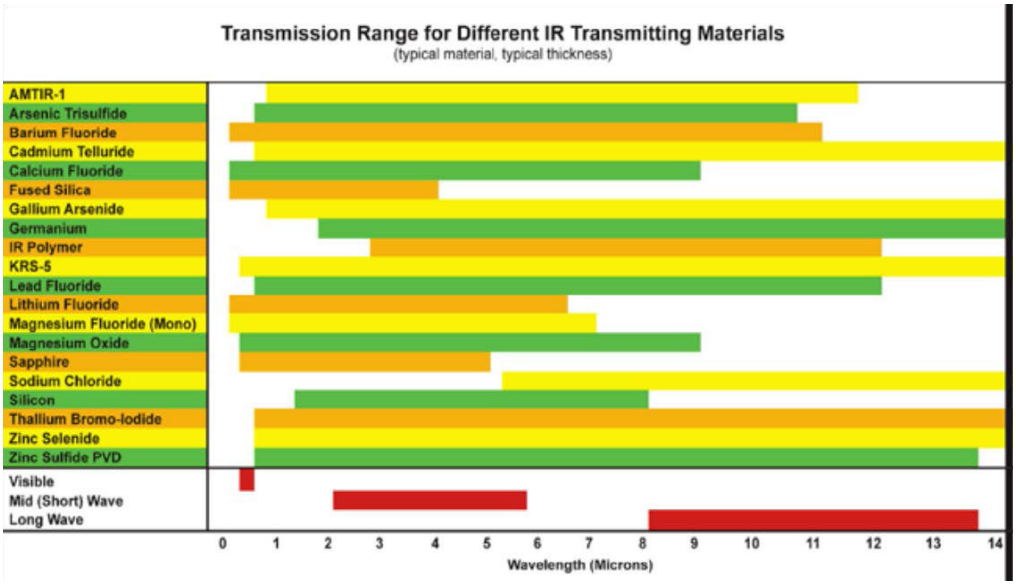
If your application is to look at extremely hot areas in a steel making operation or a boiler, you will want to consider the melting point of the lens material that you are considering. The most widely used high temperature substance is the sapphire lens.

Hygroscopic Properties

Crystals are grown in a supersaturated solution. Most people are familiar with growing a “rock candy” crystal using table sugar with heated water allowing a super saturated amount of sugar to go into solution. As the solution cools, rock candy crystals begin to grow on a piece of string. Unfortunately, many of the IR lens material listed above is grown this same way and therefore are hygroscopic or tend to absorb moisture. Manufactures have tried to minimize this by coating the crystal lens with various materials to keep the water out. But, over time, the lenses will absorb moisture from the environment and cloud over. This means the ability of the lens to pass through the IR information is compromised. This can cause faulty readings using the IR camera.

Health Hazards

Read through the above list and you will recognize some heavy metals and dangerous compounds such as arsenic, barium, cadmium, gallium, lead, lithium, and thallium. Most health and safety experts agree that these materials are not the types of materials you want people coming into contact with. Since the crystals that are made up of these materials are fragile, it is possible that a broken crystal can pose a health threat.



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When choosing an IR window lens material, consideration must be given to the type of IR camera that will be used in the thermography inspection. There are two types of IR cameras in use:

- Medium Wave
- Long wave

The infrared spectrum is considered to range from about 0.5 to 14 microns.

Short Wave

The short wave infrared camera covers the spectrum of about 2 to 6 microns. This is most often usedfor high temperature measurements. The IR material of choice for this part of the spectrum is a sapphire lens material.

Medium Wave

The medium wave cameras are the type used in law enforcement and military. These are not typically used in an industrial environment.

Long Wave

Long wave cameras will cover about 8 to 14 microns. This is the type of camera used in industrial environments

The selection of materials depends on:

- Health and safety concerns,
- The temperature of the environment
- The ability of the material to transmit the IR energy.

Barium Fluoride

In the past, barium fluoride was widely used. This is because of the excellent transmission properties of the lens material. It transmits very well in the range of 8 to 11.5 microns. The problem is that barium chloride absorbs moisture from the environment in the neighborhood of about 100 times more than its cousin, calcium fluoride. At the same time, barium fluoride is about 100 times more fragile than the calcium fluoride alternative. In addition, barium fluoride has been shown to be a known carcinogen. Therefore a broken barium fluoride crystal can expose plant personnel to a substance that the health and safety will not risk.

Calcium Fluoride

Calcium fluoride is the least expensive and safest with regards to health and safety of the crystal lens materials. It has a transmission range of about 0.5 to a little over 9 microns. Note that most industrial IR cameras cover the 8 to 14 micron range. But, calcium fluoride crystals are hygroscopic meaning that they will absorb moisture from the environment and will eventually have to be replaced. This does not happen quickly. The crystal's transmission properties will change gradually over time and the danger is that the thermographer may not realize the problem until it is so severe that a fault occurs. An impact on the enclosure, transmitted machinery vibration or hitting the lens material can cause cracking and failure. When the crystal breaks, the pieces can fall into the gear disturbing the electrical environment. Now a large diameter hole exists that can allow dirt, debris, and tools to enter the electrical plane.

IR Polymer Lens

A few years ago, IRISS introduced an IR polymer lens material made of a polyolefin material. This IR lens material has a fixed and stable transmission rate. This means that once the transmissivity value of the lens is determined, it will not change over time. The polymer lens material is less expensive to manufacture and this savings is passed along to IRISS customers making it the most inexpensive industrial IR window available. In addition, the IR polymer window is the only IR window that has passed UL testing for impact and flammability. The impact is important, because it is unaffected by machinery vibration or direct impacts. This is due to the dual hexagonal grill design. The polymer is sandwiched between the grill to not only keep it impact resistance, but to also limit the hole size to 5/8 inch if a hole did develop. The polymer begins to turn to a wax at about 325 C and will not sustain a flame. The normal operating temperature of the lens is 100 C. If the surface of the electrical panel is 100 C, then you have more to worry about than the functionality of an infrared window.

IRISS manufactures both a calcium fluoride crystal (the IRISS VPFC) and an IR polymer lens (the VPFR) in 2, 3, and 4 inch sizes. For most industrial applications, IRISS recommends the VPFR because it is less expensive, more robust, and has a fixed and stable transmission rate. But, if a customer insists, we will sell the customer an IRISS VPFC calcium fluoride IR window.

The IRISS VPFR windows are the only windows that have passed a manufacturer's 63kA, 15kV for 30 cycles at 60Hz arc flash testing.

CAP and Custom Solutions

In early 2010, the question was asked, "Who says IR windows have to be round?" This is a great question. In the past, IR windows were round because they were crystals. With the IRISS IR polymer lens material, an infrared window can now be made into any shape or size needed by the customer. Now manufacturers can offer a curved IR window for a special piece of equipment. Now a manufacturer can offer an IR panel that covers the entire length or breadth of a panel. In addition, IRISS adds the same type of clear window used by switchgear manufacturers to take advantage of the newer IR camera features that allow simultaneous recording of a visual as well as an IR image,

IRISS standardized on 3 CAP sizes: 6, 12, and 24 inch sizes. IRISS also makes Custom Solutions IR windows to a customer's specific shape and dimensions.

Purchasing

If you are considering the purchase of an IR window, you will probably consider:

- Price – is the price the lowest alternative?
- Technical - does the lens material offer
  - Safety?
  - Stable transmission?
  -Durability?

The IRISS VPFR polymer lenses are:

- Less expensive
- Made of benign material
- Does not support a flame
- Is impact resistant
- Will not absorb moisture
- Has a fixed and stable transmission rate