TECHNICAL SERIES: APPLICATION AND ENVIRONMENT

Application and Environmental Considerations for Optical System Design

In our previous article, we discussed how light is defined by opticians in terms of its wavelength and that their understanding of its propagation as a wave allows them to manipulate its behavior using optics. We'll now move on and begin to cover the many considerations when designing an optical system.

The first and most obvious consideration in optical design is defining the intended application. Perhaps the system will be used to image the sun in ultraviolet light; perhaps it is for biomedical imaging of human tissue or maybe it's a simple viewport that is subject to extremely high pressure or caustic chemicals. There are countless applications to choose from and each one requires careful attention to the environment in which it will operate and the specific wavelength range of interest. For example, a thermal camera used in reconnaissance on an aerial vehicle is designed to image in a specific region of the infrared, notably the portion of the spectrum where an individual can be identified by their heat signature at night. At the same time, the operating environment varies from the scorching desert heat of a tarmac, to the frigid temperatures at high altitude. An optical designer must therefore choose materials that specialize in infrared transmission but are also thermally stable across a wide range of operating temperatures.

Materials come in many different forms. There are hundreds of optical glasses manufactured for the visible spectrum. Others, such as fused silica,

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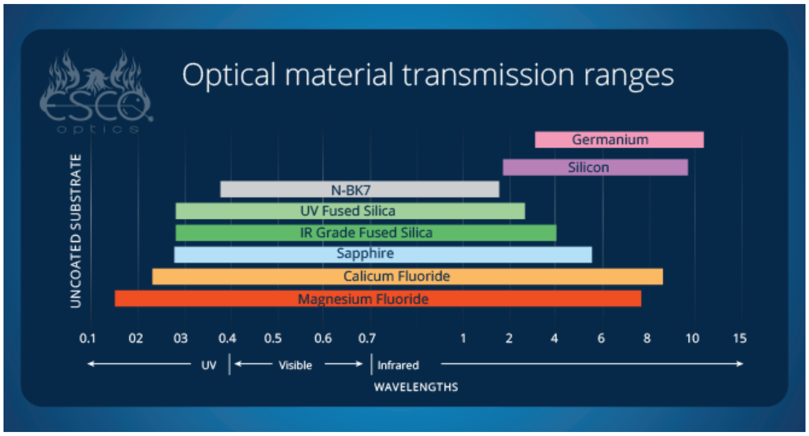
have expanded transmission ranges that extend deep into the ultraviolet, as well as, near infrared. Then there are crystal-based materials such as silicon and germanium that do not transmit at all in the visible but are transparent to infrared light. Some crystals like CaF2 (calcium fluoride) and MgF2 (magnesium fluoride) have exceptional transmission from the ultraviolet all the way to longwave infrared light. Another group of materials are absorptive filter glasses that selectively transmit some wavelengths while blocking others. Finally, and by no means the end of available optical choices, are low-expansion materials that are used as substrates for mirrors. Their low coefficient of thermal expansion allows their polished surfaces to remain very stable and precise across a range of temperatures.



As you can see, there is a great deal of overlap in transmission ranges and while several different materials may be suited for a given application, optical designers must weigh a material's performance benefits against the cost to fabricate the individual components. In this regard, the assistance of an experienced optical sales engineer is a valuable asset. At Esco, we work closely with our customers to recommend the most cost-effective solution to their optical challenges. Among the many considerations, our years of experience help us address questions such as which materials are easier to process? Which are sensitive to temperature changes? Which are more prone to scratching and degradation from environmental influences? Which materials can handle high-energy laser applications? Does a particular material fluoresce when exposed to certain wavelengths of light?

It all begins with an understanding of the application of use and environment. From there, optical designers then explore the specific optical properties of available materials in order to manipulate light to their

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desired outcome. In our next article, we'll discuss the characteristics of materials and how they are defined by the optical industry.

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Sep 23, 2016

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