TECHNICAL SERIES: LIGHT AND OPTICS

Essential Concepts to Understanding Light and Optics

Esco Optics welcomes you and is pleased to present a series of articles covering the basic concepts used in the field of optical design and manufacturing. Our goal is to provide a foundation of knowledge that is easily accessible for beginners, yet thorough enough to be used as a quick guide for anyone in the industry. As always, we welcome your feedback and encourage you to contact our technical sales engineers with your optical inquiries.

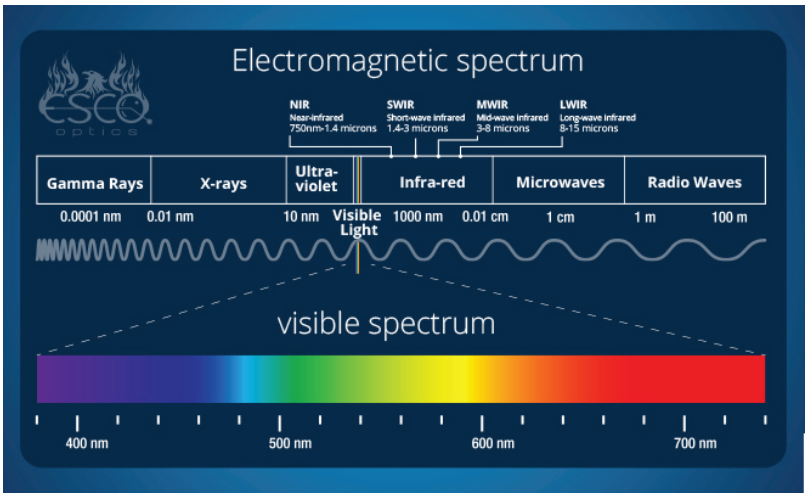
At the heart of all optical design is the intent to manipulate light. Opticians bend it, they focus it, disperse, reflect and transmit it using a wide variety of methods. Often times, there are many ways to achieve the same outcome and this is possible because light behaves in a predictable and quantifiable manner. As our discussion is intended to be topical, it is not necessary to understand the underlying physics that allow it to be harnessed and controlled, however, before we discuss how optics are used, we must first define exactly what light is.

Most often when we think of light, our minds naturally consider the rainbow of colors we see in everyday life. The sky is blue, leaves are green, and with various pigments, we can paint the walls of our houses any color we want. There is nothing intuitive to this concept, but is there more to light? The simple answer is yes, and opticians know that visible light, sometimes referred to as “white light” when composed of all colors, is only a small portion of its overall spectrum. Consider a day spent outside in the bright sunshine. We know that without precautions such as sunscreen, our skin can burn. Yet we also know that inside, under office lights, no damage is done to our bodies. How is this possible? What is causing this effect? Through careful experimentation, scientists have identified a portion of the spectrum known as ultraviolet light, a type of light we cannot see with our eyes that resides below the deepest color of violet. Conversely, above the color red, and again outside our visual range, is a portion of the spectrum called the infrared. It is there, through the use of specialized optics and cameras we can see the “color” of heat that rises from the human body, enabling such concepts as thermal imaging used in night vision equipment.

In scientific terms, all light, both seen and unseen, is called electromagnetic radiation and it propagates through space as a wave. Much like the oscillation seen on the ocean surface, light waves travel in a cyclical fashion with

corresponding peaks and troughs. Unlike water, however, the distance or "wavelength" between the peaks is incredibly small. Specifically in the visible spectrum, the wavelengths are measured in nanometers and one nanometer is one billionth of a meter! Think in terms of a common street light that exhibits a dominant yellow color. This is due to the fact that their primary light output is at 589 nanometers (nm) or 589 billionths of a meter from peak-to-peak of its corresponding yellow wavelength. The human eye is sensitive to wavelengths of approximately 400-750nm and certain species such as bees can actually "see" portions of the Ultraviolet spectrum that humans cannot.

For reference, here's an approximate breakdown of wavelengths of light across the electromagnetic spectrum:



As you can see, visible light represents a very small portion of the overall spectrum. Wavelengths that are shorter than those of visible light comprise the ultraviolet and X-ray regions, while longer wavelengths are Infrared, microwave and radio waves. You will also notice that longer wavelengths are measured in microns, millimeters and even kilometers when referring to their peak-to-peak wavelength distance.

Scientist regularly use the entire electromagnetic spectrum to explore the world around us. From the structure of atoms using X-ray crystallography, to radio and Infrared-based astronomical instruments to study the overall structure of the universe, light plays a profound role in our pursuit of knowledge!

Opticians work primarily in the Ultraviolet, visible and Infrared regions.

Through choice of specialty materials they can assemble complex lens systems to focus and image light, they can design mirrors to reflect and steer light, and even design optics to isolate very specific wavelengths while blocking others.

Esco Optics employs a wide range of manufacturing techniques to provide system designers with stock and custom lenses, aspheres, prisms, windows and mirrors across the entire UV, Visible and IR spectrum. We work closely with our customers, offering price-conscious options, so they can choose the most appropriate, cost-effective solution to their optical challenges.

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