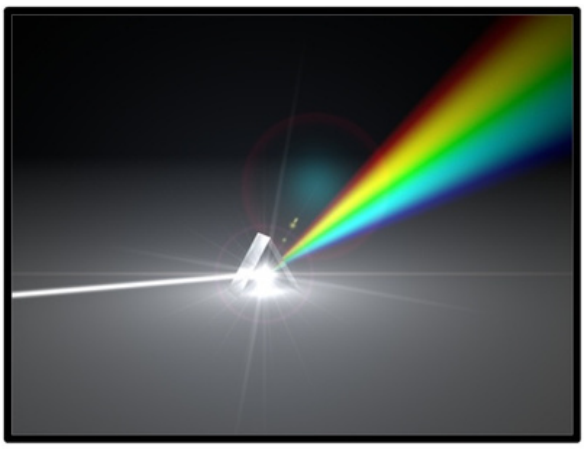
Understanding Laser Protective Eyewear Requirements

A Laser is a tool used in a wide range of applications including medical, military, industrial, entertainment, education, farming, and research. Many of these markets are taking advantage of the capability, flexibility, and efficiency that Lasers provide. The word Laser is an acronym for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.

Laser Light

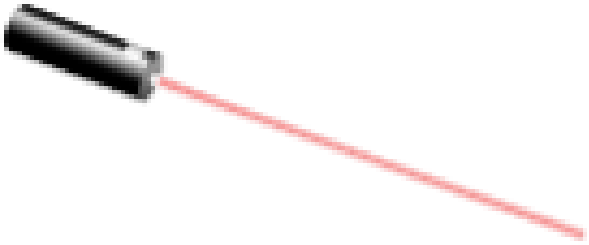
A Laser produces light at a single wavelength that is monochromatic, directional, and coherent. To break that down, monochromatic light is emitted at a single wavelength vs white light which is a combination of many different wavelength



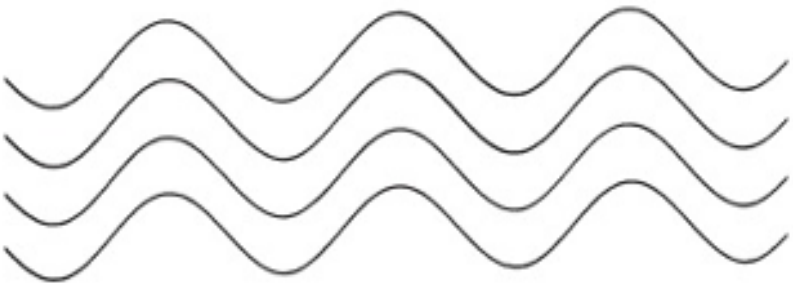
White light split by a prism into various wavelengths

Continued Page 2

Depending on the wavelength of Laser light emission, it may be visible or invisible. Laser light is emitted as a relatively narrow beam that follows a single direction. Finally, it is coherent which means the photons of the Laser light are in the same phase and frequency.



Focused direction light beam



Coherent Light Waves

Lasers can be combined into a Laser system that produces multiple wavelengths of light designed for a specific application. Many of these systems combine technologies with incoherent light sources such as UV or broad-spectrum flash systems, like Intense Pulsed Light for targeted applications in medical or welding. Without proper protection, radiation from Laser systems can lead to serious biological effects on the eye and skin.

The intensity and types of light utilized within a given application must be considered when designing Laser Eye Protection. Designing eye protection to meet user needs while conforming to regulations is key to creating a safe work environment.

Continued Page 3

Laser Hazard Classification

To help with identification, Laser hazard classification was established with the international standard IEC 60825-1 then adopted by the American National Standard for Safe Use of Lasers, ANSI Z136. A system of four classes identifies the hazard level and Laser exposure limit.

Class	Safety
Class 1	Safe under normal use
Class 1M	Safe for all conditions except when passed through telescopic optics
Class 2	Safe due to the human blink reflex
Class 2M	Safe due to the human blink reflex when not viewed through telescopic optics
Class 3R	Careful handing is required with restricted beam viewing
Class 3B	Hazardous if the eye is exposed directly, but safe when viewing as a diffuse reflection on a surface
Class 4	Devastating and permanent eye damage through direct or indirect viewing of the beam. Powerful enough to burn skin

Continued Page 4

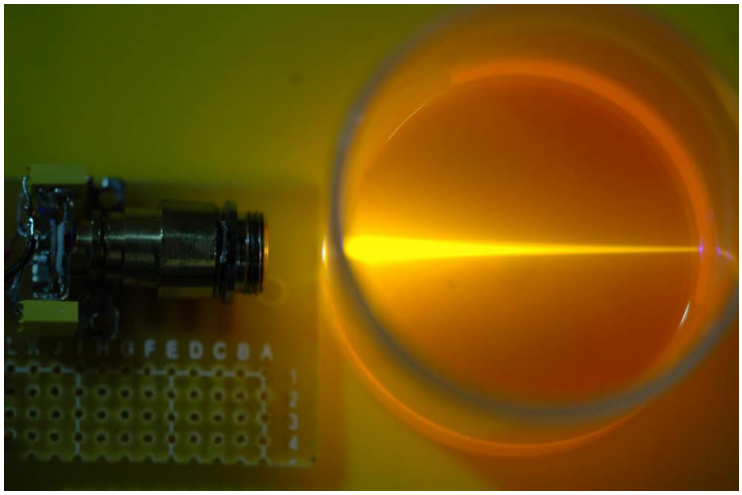
A Laser user needs to answer several important questions prior to using the Laser:

- Is Laser eye protection required?
- Are there alternate sources of light that I should take into consideration (like welding or IPL Intense - Pulsed Light).

More formally these questions are answered and monitored by an appointed Laser Safety Officer (LSO). In the US, all class 3B and 4 Laser environments are required to have an LSO. Depending on the application, LSO's may also be required for a class 1M and 2M lasers.

A Laser Safety Officer typically constructs and reviews a Standard Operating Procedure to ensure a safe environment for the user. They consider MPE (Maximum Permissible Exposure) and NHZ (Nominal Hazard Zone) calculations prevent excess radiation exposure.

Laser Protective Eyewear should be considered when the user is outside the MPE and NHZ requirements or is exposed to other light systems within their work environment. Equipment manufacturers, LSOs and users should comply with any laws, standards and guidelines set by national or local governing bodies while following any additional local facility safety protocols.



Eye Protection Standards & Certification

Standards also govern the manufacture of Laser safety equipment such as ANSI Z136.7, CE 60825-4, and CE 12254. All LSO should receive Laser safety training to properly navigate all regulations. It is important to note that Laser Protective Eyewear should never be considered the first line of defense. Use of engineering control measures, standard operating procedures, and adequate user training are key to a safe environment.

Laser Eye Protection must protect the wearer from dangerous radiation whilst allowing the wearer to safely perform essential job functions. Laser Eye Protection should provide high visible light transmittance in photopic (day/bright light) and/or scotopic (evening/dim light) conditions so the wearer's vision is not impeded.

To qualify as Laser Protective Eyewear, independent laboratory tests validate and certify the protective capabilities using the actual Laser to perform destructive testing. This certification is required to meet standards like **European norm CE EN207** and **American National Standard for Safe Use of Lasers ANSI Z136.** Bear in mind that the certification and testing process is specific to an individual type of Laser. Epolin can provide formulations and dye modeling to help target these specifications prior to the costly expense of certification testing.

Formulation of Laser protective lenses

Design considerations for lenses or filters include:

- What is the wearer trying to see?
- Laser requirements – Optical Density (OD) and Laser Emission Wavelength (nm)
- Lens or Filter thickness
- UV requirements
- Visible Light Transmission (VLT) requirements
- Scotopic Light Transmission (SLT) requirements

During the development process, Epolin will model and synthesize dyes that absorb specific wavelengths of Laser radiation. In many cases a dye formulation is built from multiple dyes to match the desired spectrum. These dyes can be added to a thermoplastic polymer, typically polycarbonate, via our internal compound extrusion process to create a **Luminate™**. **Luminate™** is ready to mold pellet built for a specified thickness and optical density. The customer can then injection mold the pellet into lenses.

After molding, lenses are analyzed by Epolin on a spectrophotometer which reads the optical density (OD), absorbance, attenuation, and transmittance from 200nm to 3300nm. This covers the spectrum from Ultraviolet through Visible Light and into the Near Infrared.

Once a target Optical Density is achieved or exceeded, the customer may elect to injection mold the final product and begin certification reinforced by Epolin's analysis that their lens will have an excellent chance of passing specifications.

If you are a manufacturer of Laser Protective Eyewear and you are looking for dyes or polycarbonate pellets for your applications, Epolin's technical team can discuss your specific Laser absorbing requirements. To learn more about these materials, contact us: epolin.com/contact-us

About Epolin:

Since 1983 Epolin has produced the highest quality materials to meet Laser Protective Eyewear manufacturer needs, with Epolight™ dyes and Luminate™ thermoplastic pellets.

Epolin is a global leader in the development and manufacture of near-infrared absorbing dyes and thermoplastic compounds. Our materials add premium performance for Laser & welding eyewear, light filters, touchscreens, night vision products, sensors, LiDAR, and security inks. Epolin manufactures and ships products from our headquarters in Newark, New Jersey USA for more information visit us on the web at epolin.com
Epolin is a subsidiary of the Chroma Color Corporation: chromacolors.com.

Epolin regional distributors include:

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