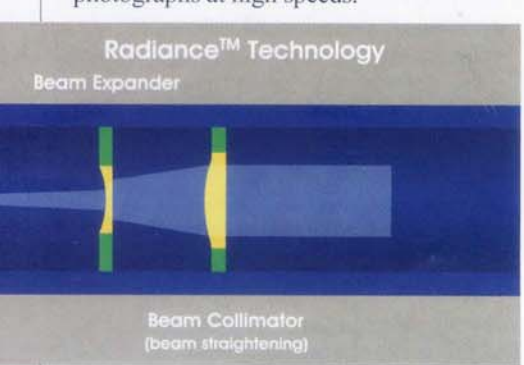
CO2 Laser Technology and High Energy Optics

By Mike Dean, Director of Sales and Marketing, Epilog Laser

In the CO2 laser systems that Epilog Laser manufactures, the laser tube is the heart of the system. The Co2 lasers operate when Co2 gas in a sealed tube is excited by RF energy. The laser emits optical energy in the form of a small, intense beam that may be used for engraving, marking or cutting a variety of materials. A CO2 laser emits an invisible infrared beam of a single wavelength that is highly directed and is focused into a very small spot size of about 0.004". The beam produces very high temperatures when the focused spot comes into contact with materials, including wood, acrylic, plastic, rubber and anodized materials.

Do Laser Tubes differ?

Epilog Laser uses Waveguide laser tube technology, which produces the best beam quality in the industry. From a technical point of view, a Waveguide laser's excellent beam quality is the product of a smaller bore, higher CO2 gas pressure, less stringent mirror alignment requirements and faster switching rates than other designs. These design elements combine to create a laser that not only is longer lasting, but is also the only sealed, air-cooled CO2 laser design capable of producing 120 watts in a sign tube design. Additionally, the super fast switching rate is one of the reasons that an Epilog Laser can engrave at such high speeds with high quality. This is especially noticeable when engraving grayscale clipart images or photographs at high speeds.



Creating a Smaller Beam

A high quality laser tube is not the only technology involved in creating crisp, sharp engraved images. To enhance the natural characteristics of the CO2 laser beam, Epilog has developed Radiance™ high energy optics system. These high energy optics, shape and refine the laser beam to create the best possible beam profile for engraving and cutting applications.

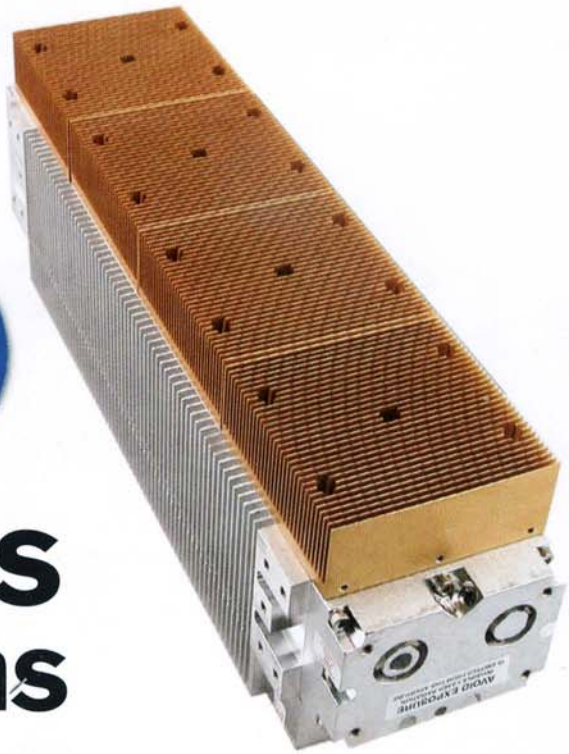
Included as a standard feature in all Mini 24, Helix and Legend 36EXT lasers systems, Epilog's Radiance optical technology helps produce the sharpest images available in any CO2 laser system today.

There are four significant advantages that Epilog's Radiance technology provides to our customers:

1) Rounder spot: A spot that is more circular in shape means that the laser characteristics are the same in both the X and Y directions, providing a more crisp engraving.
2) More uniform spot over the entire table: When a laser beam diverges, it changes size as it moves away from the laser tube. The size of the beam depends on how much the laser beam diverges and the size of the engraving table. The difference in beam size will have a significant affect on the image quality. Epilog's Radiance technology produces the most uniform spot size in the industry, even on our largest area of the 36"x 24" Legend 36EXT!
3) Smaller spot size: A smaller spot means that you can produce finer detail in engraving and cutting applications. Just look at the detail on our samples. Epilog's Radiance technology makes this level of detail easy to achieve!
4) Higher power density: When a laser beam is focused to a smaller size, its power density goes up because you've got the same amount of energy in a smaller area. This helps to produce a deeper, darker engraving than a beam from the same wattage tube that hasn't been optimized. And, when the power density goes up, it also enhances the laser's ability in vector cutting mode.

In order to understand good engraving, it's necessary to understand the importance of the laser beam and the optics it passes through from the time it leaves the laser tube until it reaches the work surface. There are three primary characteristics of any CO2 laser beam that contribute to image quality: Shape, Divergence and Size. ❑

For more information on Epilog Laser and Radiance High Energy Optics, visit www.epiloglaser.com.



Laser Sources and their Applications

By Mike Dean, Director of Sales and Marketing, Epilog Laser

There are a variety of laser sources used in systems and each has applications that work best with the different type of laser. While Epilog manufacturers CO2 laser systems and Fiber laser systems, there are different applications that fit the different types of lasers on the market. Below is a discussion on the different types of laser systems on the market and the differences between two types of laser systems – YAG and CO2.

What are the different uses for YAG and CO2 lasers?

YAG lasers and CO2 lasers react very differently on different materials because of the differing wavelengths of the laser beams. The wavelength of a YAG laser (1.064 microns) is exactly 10 times smaller than the CO2 wavelength of 10.64 microns, which makes it ideally suited for absorption in most metals, but this small wavelength inhibits its ability to be absorbed by many other materials (wood, acrylic, plastics, fabrics, etc.)

A CO2 laser beam is not easily absorbed by metal, but can easily be absorbed by many organic materials such as wood, acrylic, rubber, etc, while it tends to reflect off of most metal surfaces. It is the different wavelengths of the two beams that are mainly responsible for the different types of materials that they will react with. There are a number of other differences between the two lasers; thermal efficiency, heat transfer, minimum and maximum power output, etc. and these characteristics all have an affect on the materials that the beams react with.

There are two main types of YAG systems, the Nd: YAG, and the newer Fiber laser source, which works through a fiber optic cable.

Nd: YAG

The Nd: YAG is typically known as a YAG laser. It is used for cutting, welding, marking and machining applications. It is probably the most widely used industrial laser in the world. The YAG laser is

known as a solid state laser because the lasing material is a solid crystal of material, which is laboratory grown. The crystal is subjected to the light from a flashlamp or diode laser which caused the crystal to lase.

The two main types of YAG lasers are flashlamp-pumped and diode-pumped, which describe the light source or energy that is delivered to the YAG crystal which then produces an output laser beam.

Extremely high power flashbulbs (flash lamps) are used as pumping method in some YAG lasers. Flashlamp pumping is old technology and has been replaced in most marking applications with diode-pumping. YAG lasers are typically used in applications involving metal, including some doped plastics and some ceramics. They are generally not used with organic material including wood, cork and leather.

Fiber Laser

The Fiber Laser is a small class of lasers used for marking, drilling and limited cutting applications. The Fiber Laser is just that, a fiber optic cable, similar to the fiber optics used in telecommunications. The Fiber Laser is made of a long fiber optic cable which has a core doped with a rare element that creates a laser beam when it is excited. Fiber lasers typically use a diode laser (the same diode-pumps used in the YAG lasers) to excite the cable by firing the diode laser into one end of the cable. Each end of the cable is polished into a mirror and the whole thing is one big laser cavity.

Fiber Lasers emit around 1055 nm, to 1070 nm in the infrared range similar to YAGs. Until recently, the Fiber Laser was only available in a continuous wave (CW) mode, not pulsed. This limited its applications, primarily being useful in marking integrated circuits where the black carbon-filled plastic marks very well with fiber lasers. Newer pulsed models, like the IPG laser in the Epilog FiberMark, are becoming available now and can mark on metals and other materials formerly outside the capabilities of the fiber laser.

The CO2 laser is the other most common industrial laser available today. Most CO2s are used for cutting, from 2" steel plate to paperboard and fabrics. Lower-power CO2s are available for marking applications. The CO2 laser is a gas laser; it is essentially a bottle of CO2 gas that is excited by radio-frequency electricity and creates a laser beam.

The CO2 laser emits at 10,600 nm, or 10 times the wavelength of the YAG. This accounts for why it interacts differently with materials than the YAG. CO2 lasers are used for marking on some plastics and ceramics, some metals, and on organics like wood and leather.

Will a CO2 Laser work on any types of metals?

Yes, the CO2 will work on certain metals in a couple of different ways.

1. Coated Metals

Coated metals include painted brass, anodized aluminum, or any other metal that has been coated with a material that the CO2 laser beam will engrave away. Even a low powered CO2 laser is very effective at removing paint from most metal surfaces, with painted brass being a popular engraving material because of all the different colors available and the high contrast that is generated when it is engraved. However, some metal surfaces are painted with exceptionally hard paint coatings that even a 120 watt laser has difficulty engraving cleanly. The common products where you will see this are ballpoint pens, and anything that is powder coated.

Another metal that is very popular with CO2 lasers is most anodized aluminum. When the CO2 laser beam contacts the anodize coating, it turns it white and provides excellent contrast on the many different anodized colors. Aluminum that is protected with a gold coating is probably not anodized (it's probably protected with a process called chromate conversion) and will not engrave well.

CO2 laser systems are compatible with painted metals and anodized aluminum because of the high contrast, fast engraving speeds, low power requirements and the wide variety of projects that these materials lend themselves to.

2. Stainless Steel Metal Marking

Until recently, marking stainless steel with a low powered CO2 laser was very difficult to do. The problem is that most of the CO2 energy is reflected from the metal surface and only a small amount is absorbed, providing a very faint or non-existent mark. In the last few years a couple of different companies have introduced products that allow low powered CO2 lasers to create a very dark, permanent mark on stainless steel. The products are known as Laser Marking Materials (LMM) and go by the common name of Cermark, or Thermark. The LMM is sprayed onto non-coated stainless steel from a spray can (just like spray paint!). The LMM is allowed to dry for a couple of minutes before it is ready to engrave.

When the laser engraves on the Cermark, it permanently bonds the material to the metal, resulting in a permanent black mark. After engraving, the metal is washed with water to remove the excess spray. This simple process is often used for marking tools, medical instruments, and industrial parts with bar codes and serial numbers. LMM will also work with some other metals, but we suggest you test out any other material you are considering using to ensure the mark is acceptable. It is our experience that stainless steel is the most predictable metal for use with LMM.

Will a YAG Laser work on any types of non-metallic materials?

Unlike a CO2 laser, a YAG laser is compatible with only a limited number of materials. Because of its small wavelength, a YAG laser can mark many different types of metal, and a few plastics, but its effectiveness on standard CO2 products (wood, rubber, acrylic, etc) is almost non-existent. You will typically only find YAG lasers in industrial applications, with personalization applications limited mostly to high volume marking of products like ballpoint pens.

The reason that so many people are excited about the LMM discussed earlier is that there are a lot of stainless steel products that require laser marking and marking with a YAG laser is very expensive. ❑

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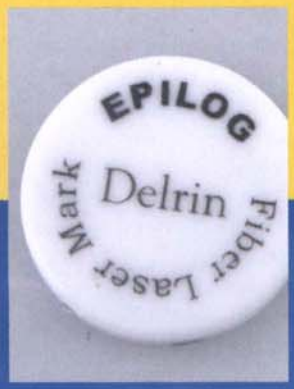

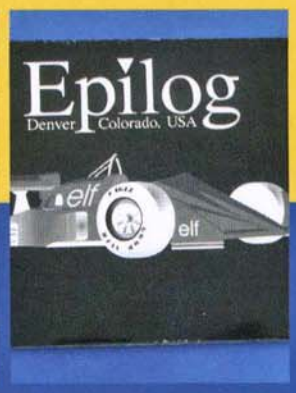

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