Laser Processing for Gasket Fabrication

More than 50 years have passed since the development of the first laser. In that time, lasers have become an integral element of many manufacturing processes from welding body panels for automobiles to cutting intricate patterns for flexible electronic circuits. In this article, we will take an in-depth look at the use of laser systems for gasket fabrication.

History of Lasers

The first functional laser was demonstrated by Ted Maiman at Hughes Research Laboratories on May 16, 1960. This was a ruby laser, which emitted a visible beam with a dark red color. Ruby lasers are still used for a limited number of applications, but they never gained broad acceptance in industry due to their high cost and low efficiency.

The carbon dioxide laser (CO_2 laser) was one of the first gas lasers. It was developed in 1964 by Kumar Patel at Bell Laboratories. The CO_2 laser gained acceptance quickly, and it is still one of the most widely used industrial laser types. It is relatively inexpensive and very efficient to operate.

CO_2 lasers emit an infrared beam with a wavelength of 10.6 microns. This wavelength is absorbed readily by organic materials such as plastic, rubber and paper, making CO_2 lasers ideal for cutting gasket materials.

How Lasers Work

The term LASER is an acronym for Light Amplification by Stimulated Emission of Radiation. Stimulated emission occurs when a molecule, in an excited state, absorbs a packet of light (a photon) with a particular wavelength. The molecule will then drop to a lower energy state and give off two photons. The two new photons are identical to each other; they have the same wavelength and travel in the same direction. This is how light is amplified within the laser. One photon generates two photons, two generate four, four generate eight, etc.

Figure 1 shows a schematic cross section of a CO_2 laser. The carbon dioxide molecules inside the laser are excited by the application of radio frequency energy. This energy causes the CO_2 molecules to emit light similar to a fluorescent bulb. Once most of the CO_2 molecules reach the excited state, the light they are emitting will have a high probability of being absorbed by another one of the excited molecules. This is when stimulated emission occurs. The original packet of light is absorbed, and two new, identical packets of light are emitted.

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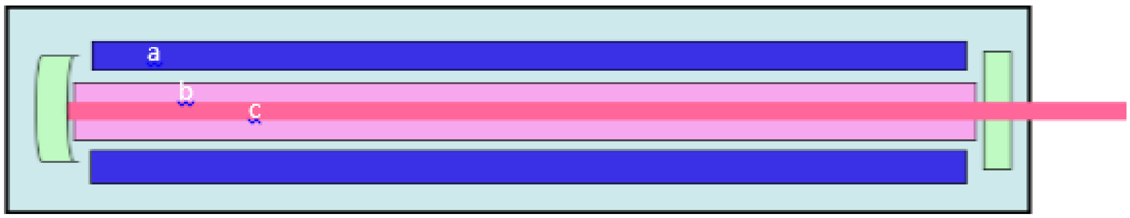

Figure 1. Schematic view of a CO_2 laser showing: a – the RF electrodes, b - the excited CO_2 molecules, c – the laser beam.

There are many laser design features that improve quality and efficiency. For example "free space" lasers provide the best beam quality. "Folded resonator" lasers provide a more compact design. However, all CO_2 lasers include the basic features shown in Figure 1.

Types of Laser Systems

A laser system consists of a laser, an optics sub-system for guiding the laser beam, software to control the laser and a platform of some sort to support the material that is being processed. There are basically two types of laser systems. These are called flat-bed and glavo systems.

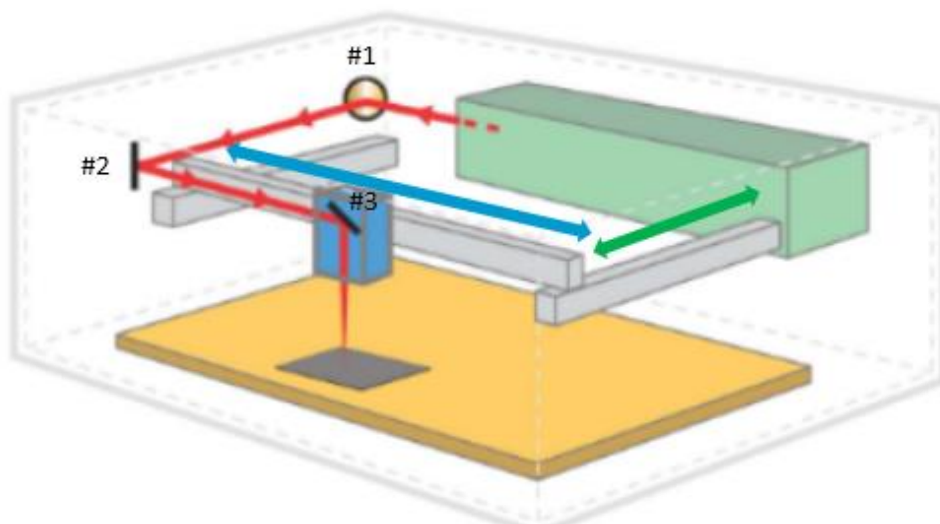

Figure 2. Schematic representation of a flat-bed laser system. The laser is shown in green at the rear of the system. The laser beam path is shown in red. The motion of the gantry on the two rails is shown by the green arrows. The motion of the carriage on the gantry is shown by the blue arrows.

In a flat-bed laser system, the material being processed is placed on a stage located inside of an enclosure (see Figure 2). The laser is mounted to the enclosure, and the laser beam is controlled by a set of mirrors. The first mirror directs the laser beam down one of two stationary rails to mirror #2. The second mirror is mounted to the end of a moving gantry (the gantry moves from front to back in Figure 2, along the two rails). This mirror directs the laser beam down the gantry to mirror #3. The third mirror is mounted to a moving carriage (the carriage moves from left to right in Figure 2, along the gantry). This mirror directs the laser beam downward toward the material that is being laser processed.

The "y-motion" of the gantry combined with the "x-motion" of the carriage allows the laser beam to follow any cutting path. Similar to a CNC router, the graphic design (CAD drawing) of a part is loaded into the laser system's control software. The control software then directs the x-y motion of the laser beam to accurately cut the part.

The design of the flat-bed laser system allows for multiple parts to be cut from large sheets of material. A 24" x 48" material support stage is common, although larger and smaller sizes are available. Since the path of the laser beam is completely contained within the enclosure, these systems are intrinsically safe to operate.

In a galvo laser system, the laser beam is controlled by two rotating mirrors (see Figure 3). The x-axis mirror controls the right to left motion of the laser beam across the work surface, and the y-axis mirror controls the front to

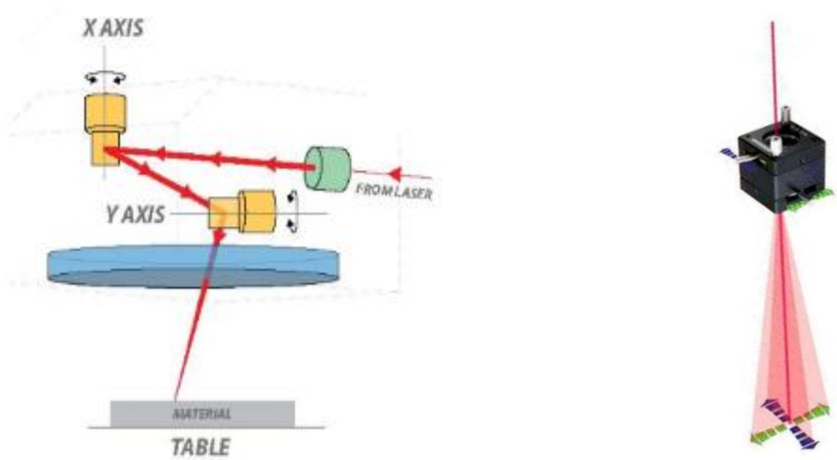

Figure 3. Schematic representation of a galvo laser system. The motion of the two galvanometer controlled mirrors is shown in the left image. The scanning motion of the laser beam is shown in the right image.

back motion. Since the only mechanical motion in the galvo system is the rotation of the mirrors, the laser beam can scan across the surface of the material very quickly. The high speed of galvo laser systems allows them to be integrated into roll-to-roll material handling systems, as opposed to flat-bed laser systems where the material typically is sheeted before being laser processed.

The down side of the galvo laser system is the scanning area is relatively small (usually about 6” diameter), so they are not very useful as standalone laser cutters. The laser beam is only perpendicular to the material in the center of the scanning area. At the edges of the scanning area, the laser beam will be cutting the material at a slight angle. This is not a problem when cutting thin materials, but it can be an issue if the material thickness exceeds about 1/8”.

Laser Processing of Gasket Materials

Most gasket materials are organic materials such as plastic, rubber or cellulous fiber sheets. This makes gasket materials ideal candidates for laser cutting and marking. Laser cutting is used to create the gasket shape, while laser marking can be used to apply a part number, bar code, logo or other identifying mark. The materials that can be readily cut and marked with a CO_2 laser include cork, neoprene, nitrile, paper, pressed fiber, rubber, silicone and Teflon™.

Figure 4 depicts a cork sheet cut with a CO_2 laser to form a complex gasket. Due to the high power density of the laser beam, the laser system can cut cleanly through the cork without leaving any residue.

Figure 4. Laser cut cork gasket.

Figure 5 shows a gasket cut from a sheet of ¼” polyurethane foam with a CO_2 laser. Foam is often difficult to die cut because it is compressed by the die, leaving a distorted edge. Since laser cutting is a non-contact process, the foam

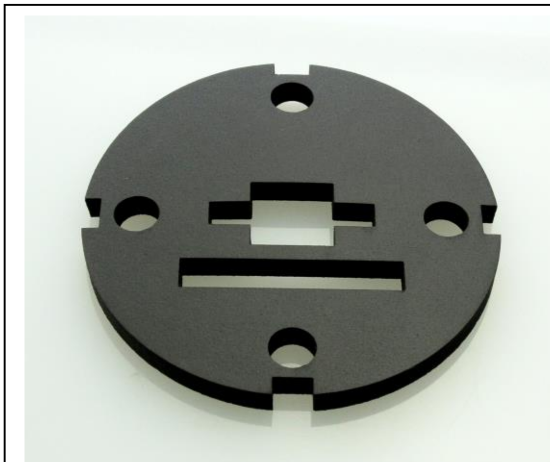

Figure 5. Laser cut foam gasket.

is not compressed resulting in a straight and square cut edge.

Silicone can be readily cut with a CO_2 laser. Figure 6 shows a gasket cut from a 1/16″ thick silicone sheet. Laser cutting silicone does create some residue, but it can be easily cleaned off with soapy water.

Figure 6. Laser cut silicone gasket.

Advantages of Laser Processing

A great deal of gasket manufacturing is for semi-custom parts. These parts need to be manufactured very quickly to meet tight customer schedules. These tight manufacturing schedules do not always allow time for die design and fabrication. Laser cutting provides an ideal solution for fast and flexible manufacturing. Laser cutting is a digital technology allowing the user to go from gasket design to finished part without the need to develop special tooling. Laser cutting is the best choice for gasket fabricators when fast turn-around time is key.

Eliminating tooling cost is another advantage provided by laser processing. A rotary die can cost several thousand dollars to manufacture. The investment can often be recouped only with a very high volume order. Eliminating the tooling removes the need to change dies to set up a new job or replace older dies as they wear out.

Laser cutting is ideal when the gasket design is complex, or if it includes small openings. Die cutting is not well suited to intricate designs, because the cut pieces tend to stick in the die cavities. With laser cutting, there is no tool surface for the small pieces to stick.

Laser cutting is also advantageous when the gasket material includes an adhesive layer. Adhesive can cause the cut pieces to stick to the die. Laser cutting has no tool surfaces for the adhesive to adhere.

Conclusions

Laser systems are valuable processing tools for gasket fabricators. Galvo lasers provide the highest value when integrated into roll-to-roll processing equipment. Flat-bed laser systems provide the highest value when used as standalone systems. Both types of laser systems produce excellent cutting quality for materials that can be difficult to die cut. Laser systems bring the added benefit of being useful for part marking as well as cutting.

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For additional information on laser processing, please contact:

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