

APPLICATION OF LASER CUTTING MACHINE IN PLEXIGLASS AND ACRYLIC MATERIALS

Posted on 2023-06-30 by redsail



Category: [Laser Cutter News](#)



Laser cutting machine is used to process plexiglass (acrylic), with fast speed, high precision and accurate positioning. It can be used to make craft gifts, panel mirror boxes, model toys, advertising light boxes, signboard displays, packaging boxes, etc.

Good cutting effect: no fire throwing, very smooth, bright, no jagged pattern, can cut 20mm acrylic at one time.

Excellent performance of the whole machine: it can work continuously for 24 hours, the Taiwan original track, accurate and durable.

Fast cutting: For example, it is used to cut acrylic sheets with a thickness of 3mm.

For the past 30 years, lasers have been used to cut and weld thin metal sheets with localized heating of the beam. This method is flexible and has high economic benefits, and is widely used in many industrial fields. In fact, the thermal conductivity of glass is lower than that of metal, so the laser should be applied to glass cutting as a matter of course. In fact, some companies have been developing complete systems since the 1970s, using kilowatt-class CO₂ lasers. However, due to the high power, the thermal impact on the glass cannot be ignored, and the local material is melted. At that time, the laser cutting technology was difficult to ensure that the cutting edge was neat and smooth, and the cutting edge still needed to be ground in many applications. At the same time, CO₂ lasers were very expensive at the time.

Laser induced separation

More recently, some engineers and academics have discovered that glass can be separated using low-energy lasers without thermal effects like melting. The language of this method is complex and involves many detailed techniques. The basic principle is to use laser-induced stress to "separate" the glass. During this period, with the maturity and development of closed CO₂ laser technology, laser cutting glass technology is more economical and practical.

In this study, a CO₂ laser with an average output power of 150W (Coherent's K-150 type) is used to form an elliptical focus point on the glass surface through the focusing optical path to ensure that the laser energy is evenly distributed on both sides of the cutting line. After the glass absorbs the 10.6-micron laser, almost all the energy is absorbed by the 15-micron absorbing layer on the glass

surface, compared with the cutting line formed on the glass surface by the laser. Choose an appropriate speed to ensure that there is enough laser heat to form a local stress distribution (set cutting line) on the glass surface to prevent the glass from melting.

In the laser cutting process, the quenching gas (water) nozzle is the quenching gas (water) nozzle. As the laser spot moves, the quenching gas (water) nozzle blows cold air (water) onto the glass surface, breaking the cold air (water) from its maximum direction, so that the glass is separated along the set direction.

It should be pointed out that to cause the glass to break, the tiny initial crack must first be scratched mechanically at the starting point of the cutting line.

Selecting processing parameters such as laser power and spot scanning speed, the fracture depth caused by stress can reach 100 microns to several millimeters, that is, the laser method can gradually cut glass from 100 microns to several millimeters.

Since this process depends on thermodynamic stress, its fracture depth and cutting speed are closely related to the expansion coefficient of the material itself. Generally speaking, glass suitable for laser cutting should have a minimum expansion coefficient of $3.2 \times 10^{-6} \text{K}^{-1}$. Fortunately, most common glasses can meet this requirement.

Achievements and Applications

This new method has some significant advantages over traditional mechanical cutting methods. First, this process can be completed in one step, dry processing. The edges are smooth and clean and do not require subsequent cleaning and sanding. Furthermore, the laser-induced separation process produces high-strength, naturally tempered edges free of micro-cracks. By adopting the method, unpredictable cracks and cracks are avoided, the rate of defective products is reduced, and the output is increased.

Edge quality

The dynamic difference of three different cut marks on 1.5 mm thick glass flakes was qualitatively analyzed. The cut edge is clean, no cracks, no cracks, and no subsequent processing procedures.

Since the laser is a non-contact tool, there is no tool wear problem, so it can ensure continuous and uniform cutting thickness and edge quality. In contrast, 3(b) shows the case of trimming with a metal wheel, where various residual tension components can be seen along the cut line. 3(c) is the result of cutting with a diamond wheel, and in many applications, many tiny cracks can be seen, requiring grinding to cut the edges.

For quantitative evaluation of edge quality, the laser-cut edge should be measured with a Stylus profiler in accordance with ISO3274. Official tests show that the average roughness (Ra) is less than 0.5 microns.

Boundary strength

Due to the good edge quality and the natural tempering action produced during the heating/quenching process, the laser cut edge strength is very high. DIN5230011 parameters have been independently tested by the Otto-Schott-Institut in Jena and the relevant data has been published. Using this method, the edging strength was increased by about 30% compared to the machined specimen.

Thickness and cutting speed

There are three factors that affect the cutting speed: glass thickness, material thermal expansion coefficient (see Figure 2), and laser output power. In this experiment, a CO₂ laser is used with an output power of 150W, a cutting $a=7.2 \times 10^{-6}$, a glass thickness of 1.1 mm, and a straight line cutting speed of 500 mm/s. In contrast, glass of the same thickness can be cut with the same hard metal wheel at speeds of up to 1500 mm/s. However, even in speed-critical applications, the economic and quality advantages of laser cutting can make up the difference. We all believe that further optimizing the processing technology and using laser cutting with higher output power can increase the processing speed by 2-3 times.

Curved cut

Since the cracks are precisely traced on the laser beam, laser-induced separation can cut very precise curvilinear patterns. In fact, the experiments we have done also prove that laser cutting can

achieve continuous and precise setting patterns in the case of straight lines or curves, with a repeatability of up to $+50\mu\text{m}$. This enables precise cutting of curves and 3D graphics.

Laser separation technology will replace mechanical methods in many glass cutting applications. In recent years, laser cutting has shown strong technical advantages in the following three application areas: cutting of CRTS, flat panel display, and automobile windshield glass.

Some applications require special post-processing of the glass, for example, some safety glass elements are temperature hardened, and most silicon-coated flat panel display elements must be temperature annealed. This particular post-processing method matches the laser-induced separation method. We cut 100 pieces of 4mm thick glass which were not damaged during the special heat treatment.