

Laser Processing Guide: Working with Polycarbonate

There are three processes that can be performed with polycarbonate: direct marking using a fiber laser, direct marking using a CO₂ laser and cutting with a CO₂ laser. This document will provide general information about processing each of these methods, as well as the advantages and limitations for each of these options.

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Direct Mark with Fiber Laser

The 1.06 μm wavelength of the fiber laser is very efficiently absorbed by polycarbonate. The laser is able to quickly heat the surface of the polycarbonate, causing a dark mark. This can either be brown to a black mark depending on the process settings and image density settings used.

Creating a Mark

Creating a surface mark on polycarbonate is very straight-forward using the fiber laser and the standard Materials Database settings for polycarbonate. Using image density 6 gives the highest contrast mark. The 4.0 lens is recommended for improved uniformity in the mark. This also helps with samples that are not completely flat or are slightly distorted because the focal tolerance for the 4.0 lens is $\pm 0.04''$.



Figure 1: Fiber laser marked sample

Advantages/Disadvantages

- This option produces a high contrast black or dark mark, which can be used for general marking, images, or barcodes.
- This laser produces extremely fine detail, with spot sizes ranging from 0.00025" to 0.0025".
- The fiber laser is only available as an option on the PLS6MW system. This is due to added safety features on that platform intended for the use of 1.06 μm wavelength light.

Direct Marking with a CO₂ Laser

The 10.6 um wavelength of the CO₂ laser is not as efficient at absorbing laser energy as the fiber laser. CO₂ lasers tend to make marks that are a yellow or light brown in color. It is recommended that you use a masking on the surface you will be marking to prevent buildup of debris or undesirable discoloration.

Creating a Mark

Creating a surface mark on polycarbonate can be done with any lens option (HPDFO, 1.5, 2.0, 2.5, 3.0 or 4.0). Your lens should be selected based on the level of detail required for the job (spot size) and any focal tolerance or focal distance requirements due to part shape.



Figure 2: CO₂ laser marked sample

Advantages/Disadvantages

- This mark can be made with any Universal Laser CO₂ system and any lens option for added versatility.
- This process does not create a high contrast mark. Marks tend to be yellow or light brown mark.
- There is a relatively large heat affected zone which limits the crispness of the marking.

Cutting with a CO₂ Laser

Due to the chemical structure of polycarbonate, edge discoloration cannot be avoided while laser cutting, but it can be minimized. It is recommended to use the highest wattage laser possible and the protective liner should be left on or use a masking to protect the surface from discoloration. Air assist helps to reduce flame ups and helps to cool the cut material, which can also help reduce the discoloration. The typical Materials Database process was designed for a broad range of thicknesses, but it can result in char and/or discoloration of the edge surface. When better edge quality is required, the Smooth Edge Method is recommended.

The Smooth Edge Method discussed below can result in a glass like edge, but it is still discolored. This method requires higher wattage lasers, has a lower process speed and has a lower maximum cut thickness when compared to the typical polycarbonate Materials Database process. The 2.0 lens is recommended for the Smooth Edge method.

Typical Polycarbonate Cut

Using the standard Materials Database settings and cutting in only 1 pass, you will typically see char and discoloration (as seen in the micrograph to the right). This is useful on the thicker polycarbonate that cannot be cut well using the Multi-Pass or Smooth Edge methods. This method also results in a faster process speed, compared to the other methods. Thicker polycarbonate will tend to result in more char and discoloration than thinner polycarbonate.

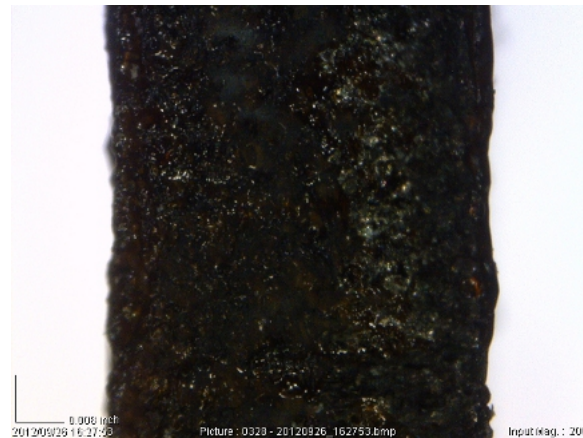


Figure 3: Micrograph of a laser cut polycarbonate edge using the typical method

Multi-Pass Polycarbonate Cut

Utilizing a multi-pass method, you can decrease the amount of char created while cutting polycarbonate. Starting with the Materials Database settings, then increase the speed such that after 2-4 passes the part can be easily popped out by hand. This method is useful on thicker polycarbonate when you do not have a high enough wattage laser to use the Smooth Edge method.

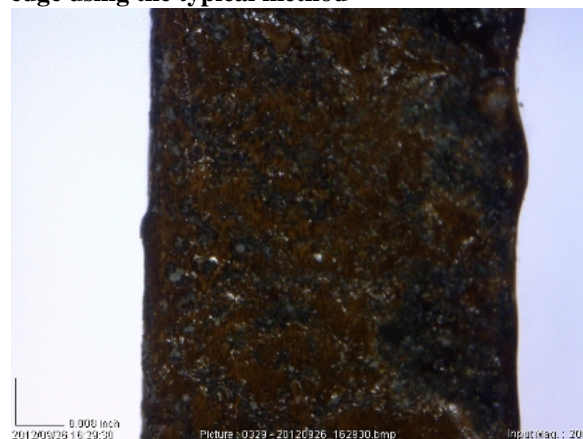


Figure 4: Micrograph of a laser cut polycarbonate edge using the Multi-Pass Method

Smooth Edge Polycarbonate Cut

This special method results in a superior edge quality (near glass like) but still results in some edge discoloration. The drawback to this method compared to the standard database settings is that it requires higher wattage to cut the same thickness of polycarbonate, and the processing speed is slower. It also has a thinner maximum cut thickness than the standard Materials Database process. Starting with the Materials Database settings, reduce the Power to 50% and set it for 400 PPI. Then reduce the speed to slightly over half the database setting. Then fine tune the speed so that it is as fast as you can go while still being able to easily pop the sample out after 1 pass. For 1/16" thick polycarbonate, a 75 watt laser is recommended. It is possible to use a 50 watt laser or lower, but the edge quality will degrade as the wattage of the laser decreases. 150 watts is recommended to cut up to 1/8" polycarbonate. As with the 1/16" polycarbonate, lower wattage lasers than recommended can be used, but will result in lower and lower quality of edges.

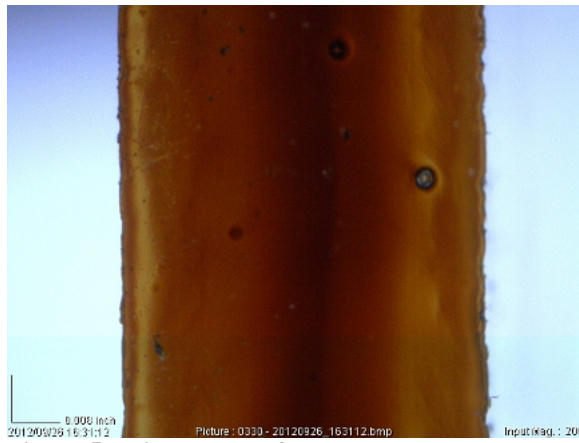


Figure 5: Micrograph of laser cut polycarbonate edge using the Smooth Edge Method

Advantages/Disadvantages

- The Typical Materials Database process
 - Will result in char and/or discoloration of the edge surface
 - Can cut thicker polycarbonate
 - Has a higher process speed
 - Requires lower wattage lasers
- The Multi Pass Method
 - Requires 2-4 passes
 - Faster than the Smooth Edge method, but slower than the Materials Database process
 - Less char than the Materials Database Process, but more char than the Smooth Edge Method
 - Cuts thicker polycarbonate than the Smooth Edge method, but thinner than the Materials Database process
- The Smooth Edge Method
 - Results in a glass like edge surface
 - Eliminates the char and edge discoloration can be minimized
 - Requires higher wattage lasers
 - Has a lower processing speed
 - Has a thinner maximum cut thickness