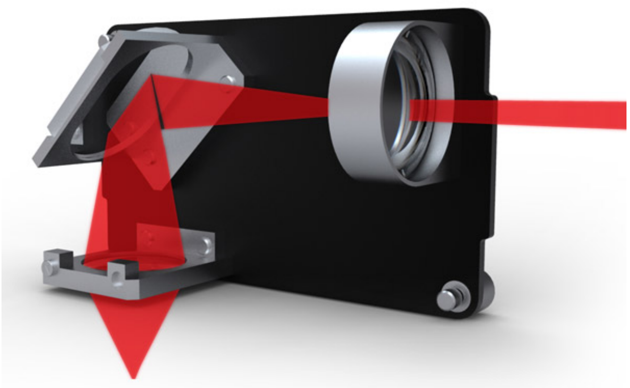
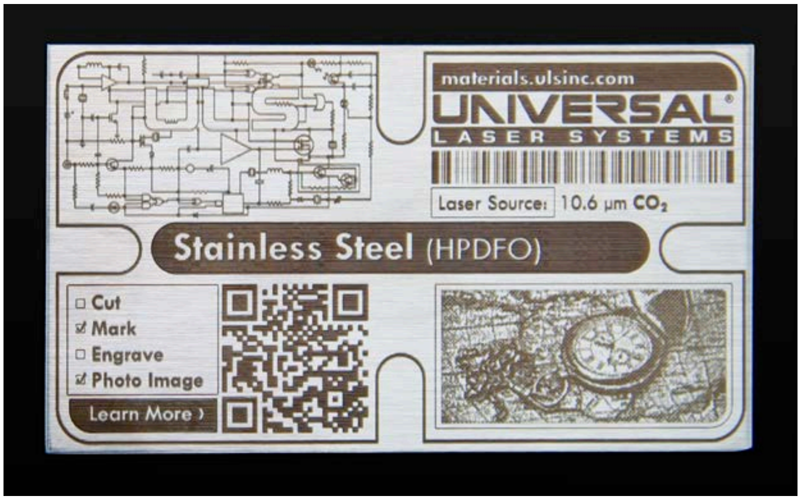
Laser Processing Guide: Marking Stainless Steel

There are three options available for marking stainless steel: direct mark using a CO_2 laser and High Power Density Focusing Optics (HPDFO™), metal marking compound using a CO_2 laser, or direct mark using a fiber 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.

Direct Mark with HPDFO and CO_2 Laser

Using the HPDFO, it is possible to produce a direct mark on steel with a CO_2 laser. The 10.6 um beam produced by the CO_2 laser is typically not absorbed efficiently by metal, so the HPDFO was created to overcome this limitation. This lens concentrates the laser beam to a higher energy density, heating the steel's surface and ultimately allowing oxidization in ambient air. This creates a dark brown oxide over the laser-marked areas; the mark is high contrast and easily legible.





Creating a Mark

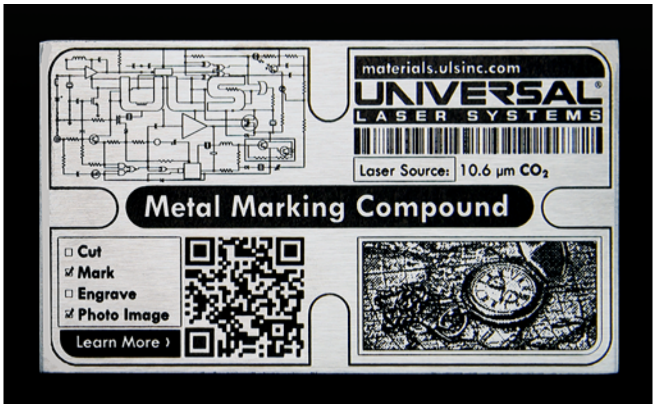
The process of using the HPDFO is very straight-forward. Simply install the HPDFO and focus to the top of your steel. The focal tolerance for this is relatively shallow (+/- 0.030"), so this process works best on consistent, level pieces. You can select laser settings from the Materials Database for stainless steel marking.

Advantages/Disadvantages

- This is a permanent, direct mark on the steel's surface.
- This option produces a high contrast brown mark, which can be used for general marking, images, or barcodes.
- The HPDFO and collimator system can be added to any ULS platform to enable this type of marking.
- The spot size for the HPDFO is very fine, 0.001", allowing the user to create intricate details on stainless steel.
- This process works for bare stainless steel, with non-polished surface finishes delivering the best results.
- This method is the slowest marking option, but it is available to add to any system and does not require application and cleanup like the marking compound.

Metal Marking Compound with CO_2 Laser

Metal marking compounds are chemically based, thermally activated laser marking products that contain ceramic particles. In this case, the compound is applied to the surface of the steel and allowed to dry. As the laser beam heats this compound, the ceramic particles fuse to the surface of the metal, creating a very high contrast black mark. This mark is nearly permanent: it cannot be removed without excessive friction and force, usually resulting in damage to the underlying steel.



Creating a Mark

The process for creating a mark using a marking compound is fairly straight-forward, but it does require additional setup and cleanup time. The compounds are available in a variety of forms, including aerosol sprays, pastes, and tapes. It is best to clean the steel surface prior to applying the compound to ensure a consistent bond. Once the compound has dried, the part can be laser marked using any CO_2 system 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. The Materials Database includes settings for using metal marking compounds with the 2.0 lens, so some adjustment may be required to achieve the best results with other lens options. Once laser marking is complete, remove the part from the laser system and clean it according to the package directions (typically washing with water or a wet towel will suffice). The compound will only adhere in the laser marked areas, producing a sharp, high-contrast mark.

Advantages/Disadvantages

- This option produces a high contrast black mark, which can be used for general marking, images, or barcodes.
- The compound can be used with any Universal Laser CO_2 system and any lens option for added versatility.
- The compound requires less intensity to bond to the surface than either direct marking process, allowing higher marking speeds. However, the compound must be applied prior to laser processing and the excess must be cleaned from the steel afterward, adding to the total processing time.
- The mark is a raised surface, due to the ceramic-based compound fusing to the metal. This may not be suitable for some applications.
- The steel must be bare for the compound to fuse to the surface.

Direct Marking with Fiber Laser

The 1.06 um wavelength of the fiber laser is very efficiently absorbed by steel. The laser is able to quickly heat the surface of the metal, causing oxidization in ambient air to form a permanent mark.

Creating a Mark

Creating a surface mark on steel is very straight-forward using the fiber laser. Lens selection will vary depending on any focal tolerance or focal distance considerations due to part geometry, but typically the 4.0 lens is suggested for best results on steel. Settings for are available through the Materials Database for processing.

Advantages/Disadvantages

- This process produces a permanent, direct mark on the metal's surface.
- This option produces a high contrast black mark, which can be used for general marking, images, or barcodes.
- Settings can be altered to produce a broad variety of marks on stainless steel. These include permanent light, midtone, or dark marks as well as a variety of colors. These lighter marking options can be used to improve throughput.
- 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 um wavelength light.
- Direct marking using the fiber laser is a faster marking option than HPDFO with a CO_2 laser, however it is not as fast as marking using metal marking compound with a CO_2 laser.

This image is a side-by-side comparison of the three marking methods, beginning at the top with direct marking with the fiber laser, then direct marking with HPDFO and a CO_2 laser, and finally metal marking compound with a CO_2 laser.

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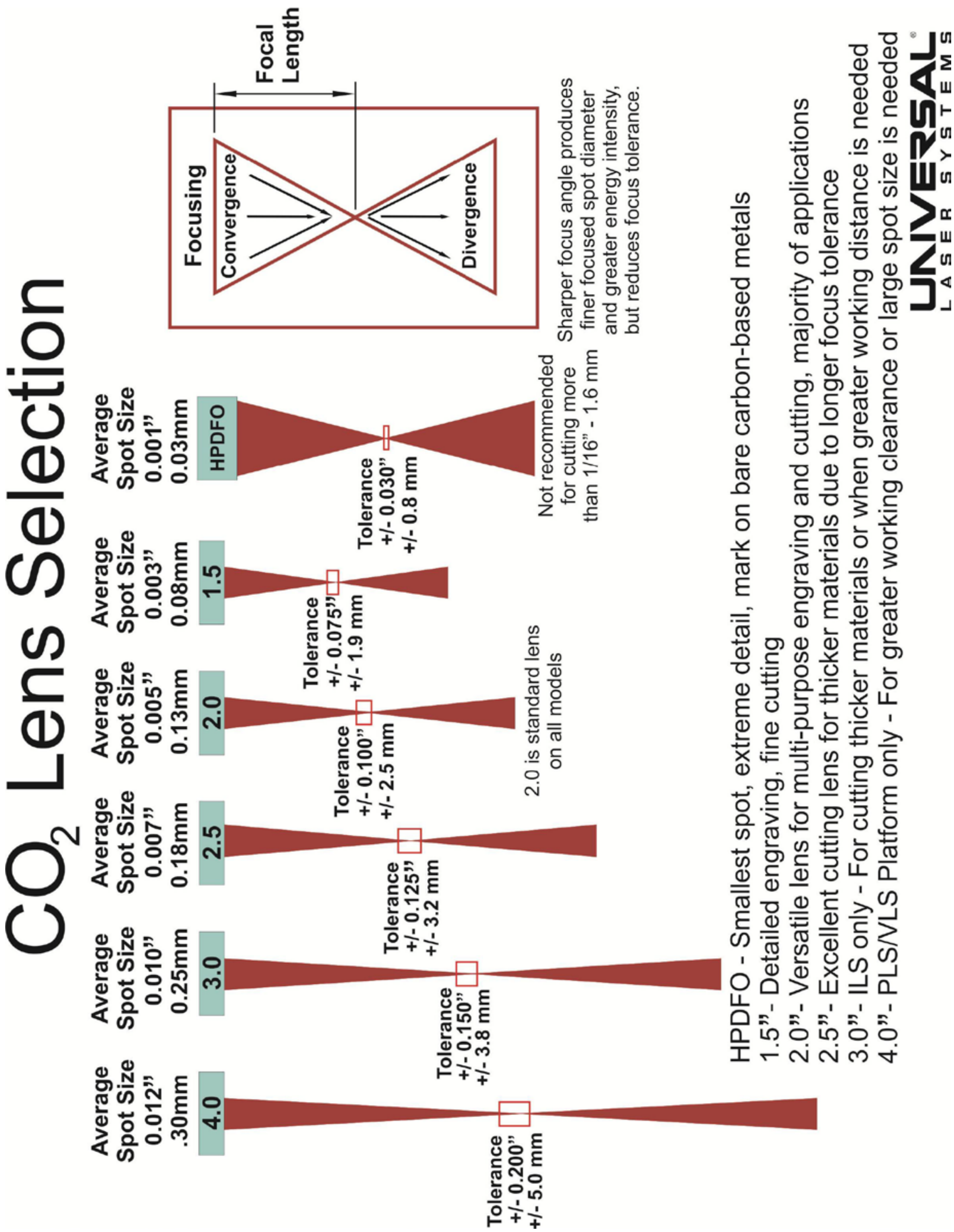
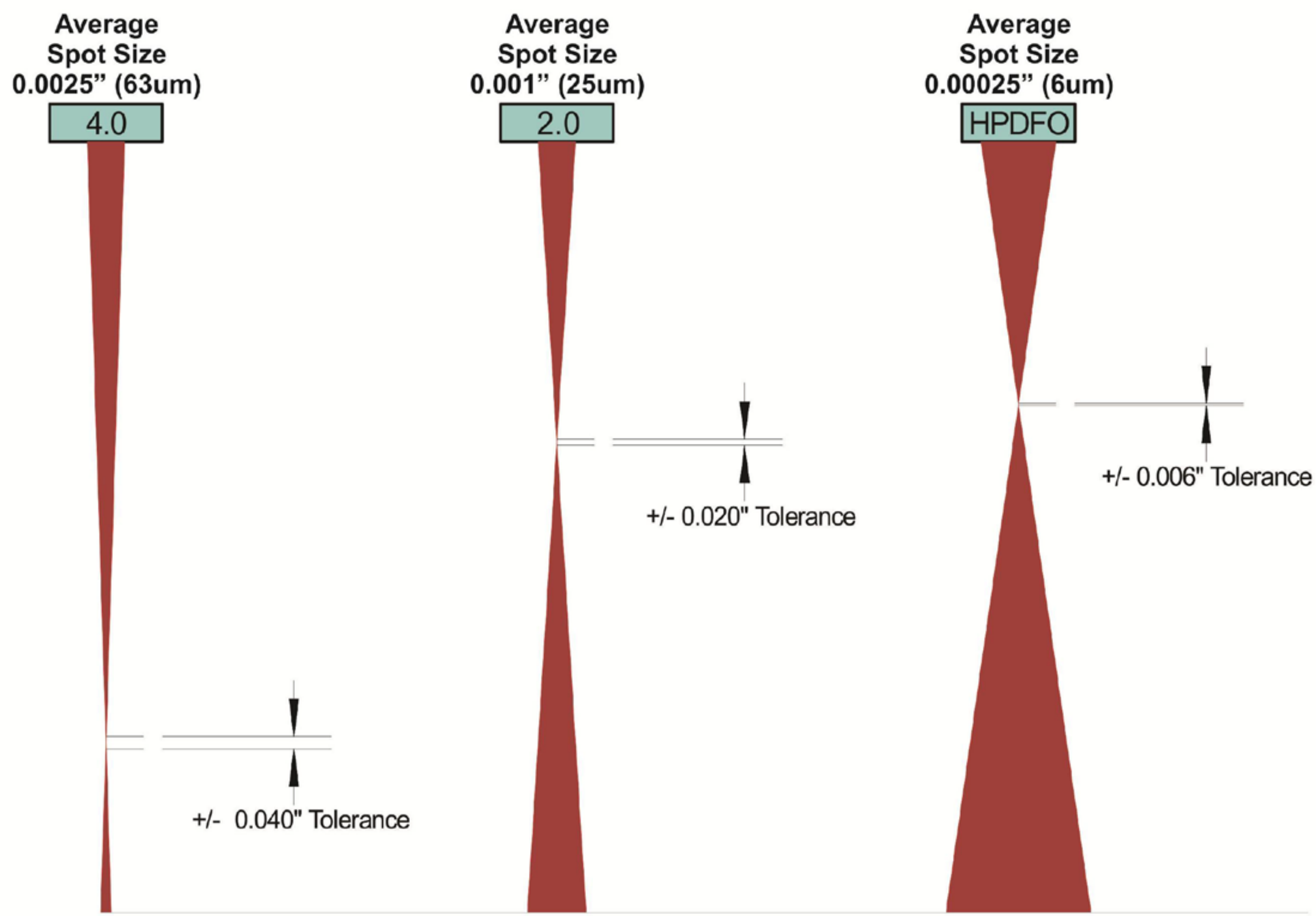


Fiber Laser Lens Selection



Focal tolerance ranges are material dependant. Some applications will be more sensitive to focus than indicated on this chart.