

Multi-Wavelength Laser: PLS6MW

Overview

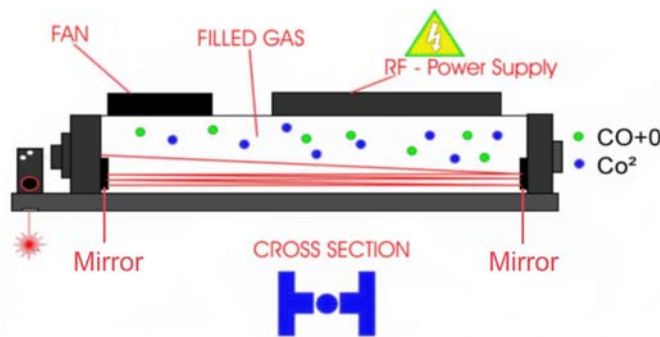
The PLS6MW is a multi-wavelength laser that will allow customers to run a wider variety of applications on a single platform. This includes a variety of metals and plastics in addition to all of the materials we can currently process with CO<sub>2</sub> technology.



This laser platform enables customers to quickly switch between a Fiber laser source and a CO<sub>2</sub> laser source. It includes our Rapid Reconfiguration™ technology and pre-alignment, as well as the ULS Materials Database to make transitioning laser sources effortless. Optics can be quickly changed without tools, and the viewing window is dual-wavelength safety glass to allow safe viewing while operating either laser. The laser system functions with almost all of our standard accessories including the rotary, air assist, and 1-Touch Laser Photo™ to allow customers to process the greatest range of applications. Because of its overall flexibility and the quality it delivers, the PLS6MW provides seamless scalability from product development through manufacturing. It is the ideal platform for materials research, development, and manufacturing environments.

Technical Differences in CO<sub>2</sub>, Fiber, and YAG Lasers

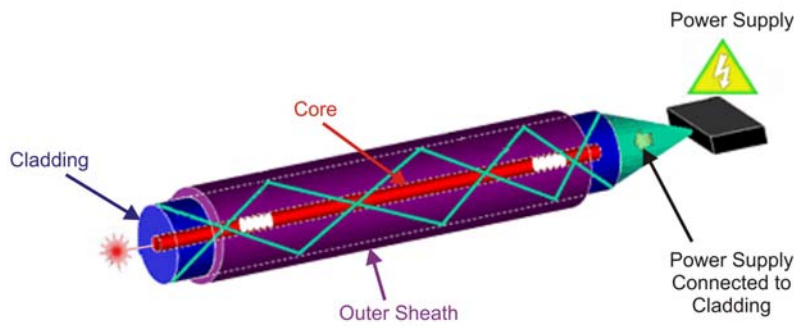
The main difference between these lasers is the lasing medium. This variation results in the formation of different laser wavelengths, affecting which materials each is best suited for.



*Figure 1: Diagram of CO<sub>2</sub> Laser Source*

**CO<sub>2</sub> Laser:** In a CO<sub>2</sub> laser, the gas is the lasing medium that produces the photons composing the laser beam. A power supply excites the CO<sub>2</sub> electrons and as they return to their natural state, each emits a photon. These photons travel throughout the laser cavity and wherever they encounter an excited electron, they cause another photon to be emitted. More importantly, the new photon will have the same wavelength and travel the same direction as the

previous photon. This is called stimulated emission, and is the process on which lasers are founded. As more and more of these photons are emitted, those traveling the length of the laser cavity will reflect from the mirrors and pass back through the gas to stimulate more photons. Eventually, there will be enough of these photons (enough energy) that they will be able to pass through the half-silvered mirror. These escaped photons compose the CO<sub>2</sub> laser beam.

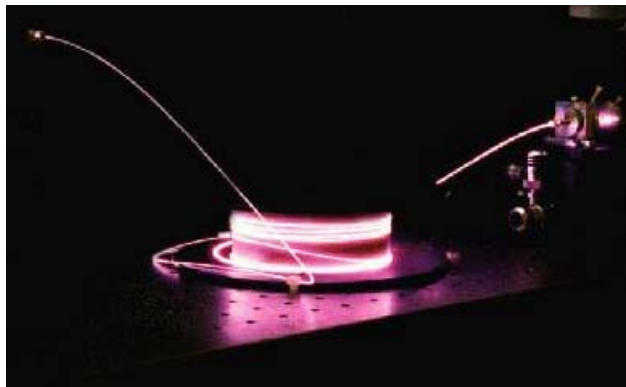


**Figure 2: Diagram of Fiber Laser Source**

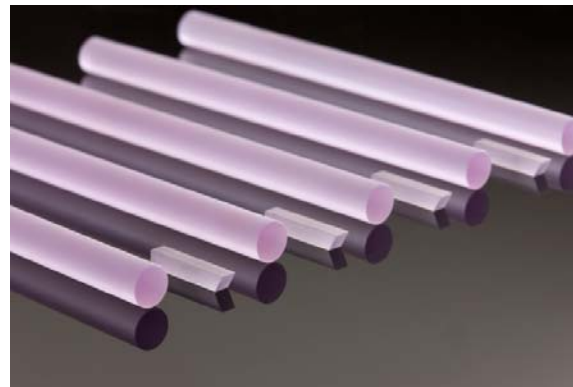
**Fiber Laser:** A Fiber laser works on the same principal: energy is used to excite electrons, they release photons, and the photons stimulate one another to eventually create a laser beam. The difference is that the lasing medium is a solid, specifically yttrium. A small glass fiber is doped with the rare metal and composes the core of the Fiber laser. The

fiber is too small to excite directly, so energy is pumped into the cladding, a layer encircling the core. This energy is contained by an outer sheath, forcing it to interact with the core. Because of this, energy can travel down the entire length of the cladding and excite the core to produce photons. The fiber itself (as well as its cladding and sheath) are several feet long and are coiled inside the laser cartridge. This means that the photons can make a single pass through the length of the fiber and produce enough energy to directly mark metal.

This setup provides additional benefits, especially when compared to the YAG laser, which produces the same wavelength.



**Figure 3: Fiber Laser Coil**



**Figure 4: Nd: YAG Crystals**

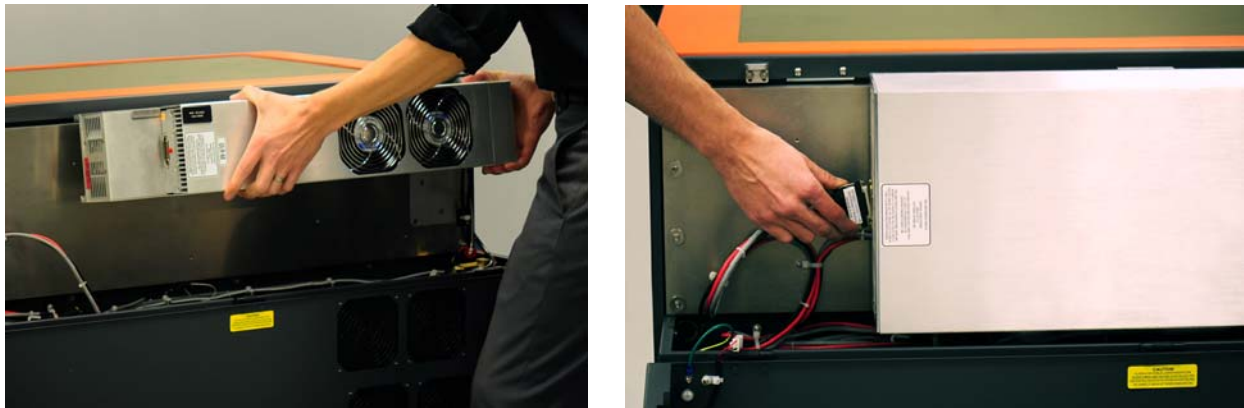
**YAG Laser:** As you can see, the YAG medium is a crystal, which will undergo the same process of photon emission as the Fiber or CO<sub>2</sub> lasers. The crystal is excited by a diode pack or lamp, which require more electrical power than the single emitter diodes used by Fiber lasers. They may also require maintenance. Additionally, YAG lasers produce a great deal of heat so they are typically water-cooled.

Fiber lasers, on the other hand, use single emitter diodes to excite the lasing medium. These require less power and should last the lifetime of the laser to eliminate maintenance. Because of the high surface area of the medium, these lasers are easily cooled with air. The Fiber laser also experiences fewer power losses because the light source is completely sealed. Therefore, although they produce the same wavelength, fiber lasers are much more efficient and reliable than YAG lasers.

## PLS6MW Platform

To accommodate the differences in the Fiber and CO<sub>2</sub> lasers, a few changes have been made to the standard PLS 6 platform. Its ease of use and base software were maintained to enable new and experienced customers alike to quickly become proficient in this technology.

The PLS6MW has three features to make changing the laser source easier: Rapid Reconfiguration™, pre-alignment, and smart interface. Rapid Reconfiguration ensures that any ULS laser source (Fiber, 10.6 μm CO<sub>2</sub>, or 9.3 μm CO<sub>2</sub>) will fit in this machine and can be attached to the laser connector cable. Pre-alignment makes it possible to change between laser sources without re-aligning the beam each time. Laser Interface+™ now has a smart feature that recognizes the type of laser installed and automatically loads the corresponding materials database and manual mode settings.



***Figures 5 & 6: Demonstrating Rapid Reconfiguration***

Physically, this machine is very similar to the standard PLS 6. Differences include dual-wavelength compatible safety glass in the viewing window, an internal lighting system, and optics that correspond to each laser type. While the mirrors have been altered to accept either wavelength, both the collimator and focus lens must be changed to correspond with either the Fiber or CO<sub>2</sub> laser. These are labeled and Laser Interface+ will provide a prompt to make certain the optics correspond to the current laser source. The collimator is magnetically secured and includes alignment pins to allow it to be easily swapped. The lens plate is the same as one found in any other platform and is changed with the same three thumbscrews.



***Figures 7, 8, 9: Changes to PLS6MW, from left: Safety Glass, Lights, Magnetic Collimator***

In the rear, a few changes have been made to the mounting blocks and alignment fork to enable the machine to accept all laser types. Due to the size of the fiber laser source (Figure 10), it is not possible to use dual lasers. However, the installation process is exactly the same as changing between two CO<sub>2</sub> lasers on any other platform.

After turning off the machine, simply disconnect the cable and the laser source can be lifted from the unit. To install a new laser source, keep the cartridge tilted as you place it on the mounting blocks and slowly move it to the right. Once the edge of the cartridge is flush with the alignment fork, carefully allow the cartridge to drop into place. Reconnect the laser cable and close the rear hatch before powering on the machine.



**Figure 10: Mounted Fiber Laser**

As previously mentioned, new lenses have been created for use with the Fiber laser. These lenses are available in two focal lengths: 2 inches and 4 inches. The 2.0 lens has a spot size of about



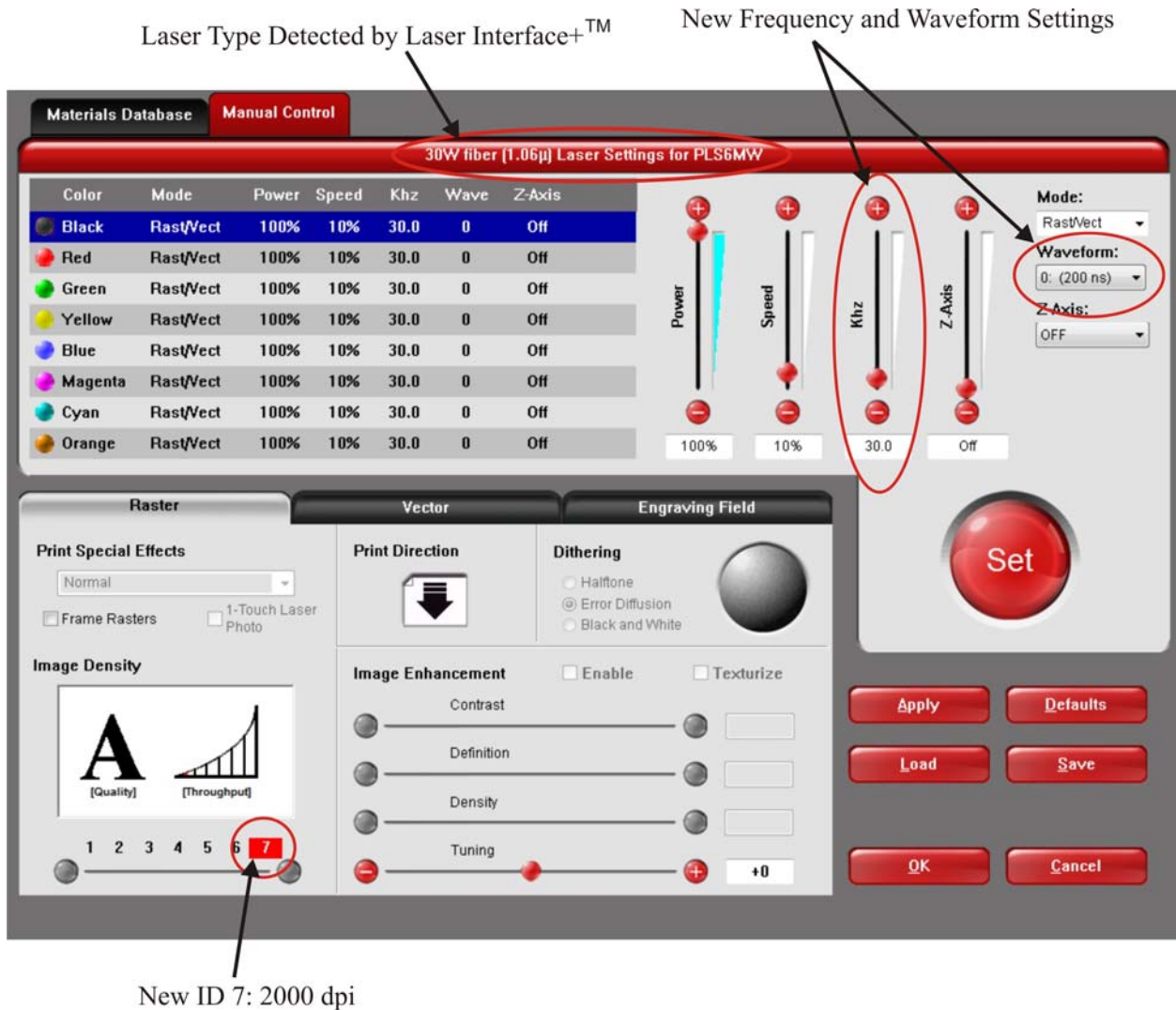
**Figure 11: Changing Lenses**

0.0005” and is ideal for extreme detail or micro-marking on flat surfaces. The 4.0 lens has greater tolerance and a spot size of about 0.001” (the same as the HPDFO™), making it more useful for a broad spectrum of applications, including marking tapered or curved surfaces and cutting.

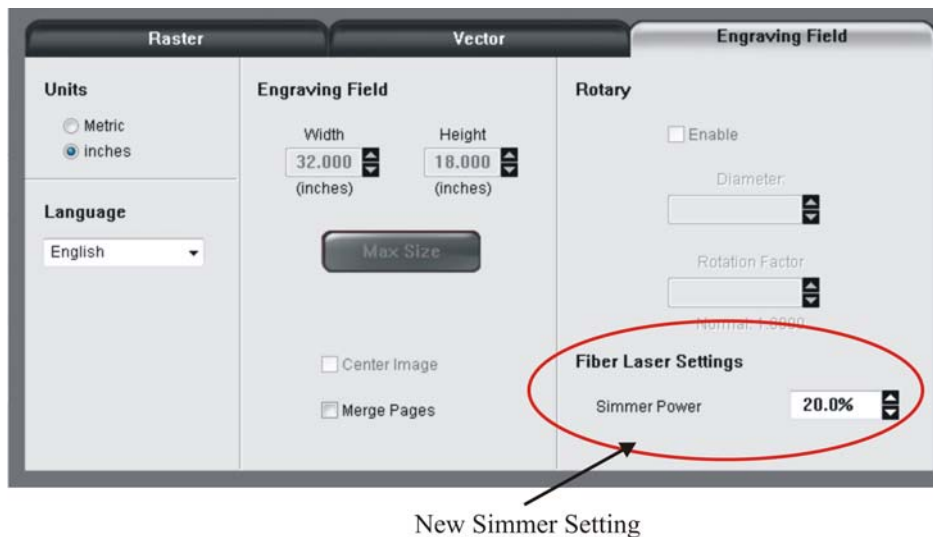
All lenses available for a standard CO<sub>2</sub> machine will also work with the PLS6MW in CO<sub>2</sub> mode, including HPDFO, 1.5, 2.0, 2.5, and 4.0 lenses. These lenses continue to function as they always have, with the HPDFO for fine detail, the 2.0 as a standard marking and cutting tool, and the 4.0 for marking deeply curved surfaces.

The ULS Control Panel will be loaded for the type of laser detected by Laser Interface+™. No changes have been made to the interface in CO<sub>2</sub> mode, but the Fiber laser interface has a few additions. These include new Materials Database settings for Fiber laser materials as well as Image Density 7, a new Waveform feature, a Frequency setting, and a new Simmer feature.

The higher Image Density is 2000 dpi, and provides the user with greater processing flexibility for working with the smaller spot sizes of the Fiber lenses. The Waveform and Frequency settings allow the user to alter their laser repetition rate and peak power to create a variety of results on different materials. The effects of these will be covered in more detail later in this guide. As you will notice in Figure 12, Image Enhancements are turned off for Fiber laser mode. These have been replaced by the Simmer feature, which affects engraving edge quality on sensitive materials. This can be found under the Engraving Field tab of the print driver.



**Figure 12: Laser Interface+ in Fiber laser Mode**



**Figure 13: Simmer Feature Located in Engraving Field Tab**

## Applications

The different wavelength produced by each of the three laser types interacts with certain materials better than others. This is what gives the Multi-Wavelength laser system such versatility and exceptional processing ability.

**Fiber Laser:** This laser operates at a wavelength of 1.06  $\mu\text{m}$  and is the best option for interacting with metals. These include stainless steel, titanium, brass, copper, anodized and non anodized aluminum, and carbide, among others. The laser can mark metals and cut metal foils. It can also mark some plastics including Delrin<sup>®</sup>, ABS, and Printed Circuit Boards, but is mostly intended for metal marking and cutting.



**CO<sub>2</sub> Laser:** This laser is available in either 10.6  $\mu\text{m}$  or 9.3  $\mu\text{m}$  wavelengths. The 10.6  $\mu\text{m}$  laser is more commonly used and can engrave, cut, and mark the largest variety of materials. These are mostly organic materials, and can include acrylic, brick, fabric, glass, leather, marble, rubber, and wood, among many others. The 9.3  $\mu\text{m}$  laser interacts well with certain plastics including PET and photopolymers. It is generally only recommended as part of a customer's Applications testing.

A chart of materials is included in Appendix A. This outlines the capabilities of each laser wavelength. 9.3  $\mu\text{m}$  and 10.6  $\mu\text{m}$  lasers are included in the same chart since they have the same interaction abilities. The differences are only noticeable on certain materials. PET and photopolymers, for example, are known to produce clearer, finer results when engraved with a 9.3  $\mu\text{m}$  laser. These are the exception, not the rule.

Most accessories will still work with the PLS6MW in both Fiber laser and CO<sub>2</sub> modes so customers can continue to enjoy the flexibility they offer. The Fiber laser will work with all accessories except Dual Head, SuperSpeed<sup>™</sup>, and the HPDFO<sup>™</sup>. The CO<sub>2</sub> lasers function with all accessories except SuperSpeed.

## Fiber Laser Applications

The Fiber laser and its additional settings open a new realm in application possibilities. While other wavelengths may have difficulty producing contrast on certain materials, the Fiber laser can often produce a variety of results and colors. These are due to varying Speed, Frequency, Waveform, Density, and changing the lens. Here are a few trends that each of these settings impacts:

- **Speed:** Higher speeds produce less intensity on the material's surface, generally leading to a lighter mark.
- **Waveform/Frequency:** These properties are linked. The Frequency must correspond to the Waveform to produce a mark. When a Waveform is selected, the Frequency field is

automatically populated with the most common setting and can then be changed to slightly alter the appearance of the mark (see Figure 14 below). Higher Waveform and Frequency values generally correspond to lighter marks.

- **Density:** As with the other Image Density values, increasing this number raises the dpi and increases intensity for a darker mark. Higher densities are also necessary for engraving with the Fiber's 2.0 lens due to the very small spot size (otherwise there will be spaces between the lines of engraving).
- **Lens:** This impacts the spot size and will depend on the given job. The 4.0 is the standard lens with a small spot size for fine detail (equal to the HPDFO™) and enough tolerance to work with tapered or curved surfaces. The 2.0 lens is ideal for very fine detail or micro-marking on flat surfaces. The spot size will also affect the intensity on the material's surface, leading to different marks.

Waveform	Frequency (kHz)
0	30
1	76
2	145
3	230
4	250
5	250

**Figure 14: Waveform Settings with Corresponding Frequency Values**

**Metals:** With most metals, the Fiber laser can produce three main colors: white, mid-tone (gray or brown), and black. The Fiber laser is also ideal for cutting metal foils. It can work with any metal foil (including reflective foils) to produce a clean cut edge.

**Plastics:** As with metals, the fiber laser can process certain plastics with excellent contrast. These include materials like ABS and Delrin®. There are many plastics (like acrylic) that the fiber laser penetrates without marking or cutting, though these work well with CO<sub>2</sub> technology.

**Coated Metals and Plastics:** The Fiber's ability to produce such a variety of results is ideal for removing coatings from materials to produce contrast. This can include removing a protective coating from parts to reveal shiny metal beneath or removing metalized paint from plastic. Because the wavelengths interact with each layer differently, it is not difficult to find settings that affect only the coating.

### Conclusion

The abilities of the Fiber laser coupled with the diversity offered by CO<sub>2</sub> technology create a huge opportunity for the laser industry. Customers no longer require separate stand-alone systems to produce the results and products they desire. Testing, prototyping, and manufacturing of hundreds of materials can now be done on a single system.

**CO<sub>2</sub> Laser Materials (Includes 9.3 μm and 10.6 μm lasers):**

Material	Engrave	Cut
ABS Plastic	•	•
Acrylic	•	•
Avonite	•	•
Brick	•	
Cardboard	•	•
Ceramic	•	
Chipboard	•	•
Corian <sup>®</sup>	•	•
Cork	•	•
Delrin <sup>®</sup>	•	•
Fabric	•	•
Fiberglass	•	
Foam	•	•
Fountainhead	•	•
Glass	•	
Granite	•	
Kevlar	•	•
Laminated Plastics	•	•
Leather	•	•
Marble	•	
Masonite <sup>®</sup>	•	
Mat Board	•	•
Melamine	•	•
Mother of Pearl	•	•
MDF	•	•
Mylar <sup>®</sup>	•	•
Nylon	•	•
Paper	•	•
Particle Board	•	•
PCB	•	
PET <sup>1</sup>	•	•
Photosensitive <sup>1</sup>	•	
Plexiglass	•	•
Polycarbonate	•	•
Polyethelene Foam	•	•
Polypropylene	•	•
Polyester	•	•
Pressboard	•	•
Resin	•	•
Rubber	•	•

Material	Engrave	Cut
Silicon	•	•
Silk	•	•
Stone	•	
Styrene	•	•
Tile	•	
Travertine	•	
Twill	•	•
Wood	•	•

**Metal Marking**

Material	Direct <sup>2</sup>	MMC <sup>3</sup>
Alumamark	•	
Aluminum		•
Anodized Alum.	•	
Brass		•
Carbide	•	•
Cobalt		•
Copper		•
Iron	•	•
Nickel		•
Painted Brass	•	
Pewter	•	•
Stainless Steel	•	•
Steel	•	•
Titanium	•	•
Tungsten		•

<sup>1</sup> The 9.3 μm CO<sub>2</sub> laser will produce better results on this material.

<sup>2</sup> Requires High Power Density Focusing Optic (HPDFO<sup>TM</sup>).

<sup>3</sup> MMC (Metal Marking Compounds) can only be used on raw metal, free of clear coating or polish.

## Fiber Laser Materials

Material	Mark	Cut
ABS	•	•
Aluminum	•	•
Anodized Aluminum	•	
Brass	•	•
Copper	•	•
Chrome	•	
Delrin <sup>®</sup>	•	
Gold	•	•
Nickel Plated Metal	•	
Polycarbonate	•	
Silver	•	•
Stainless Steel	•	•

Note: Metals listed in the cut column are foils. Other thicknesses will need to be tested in the Advanced Materials Processing Center.

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