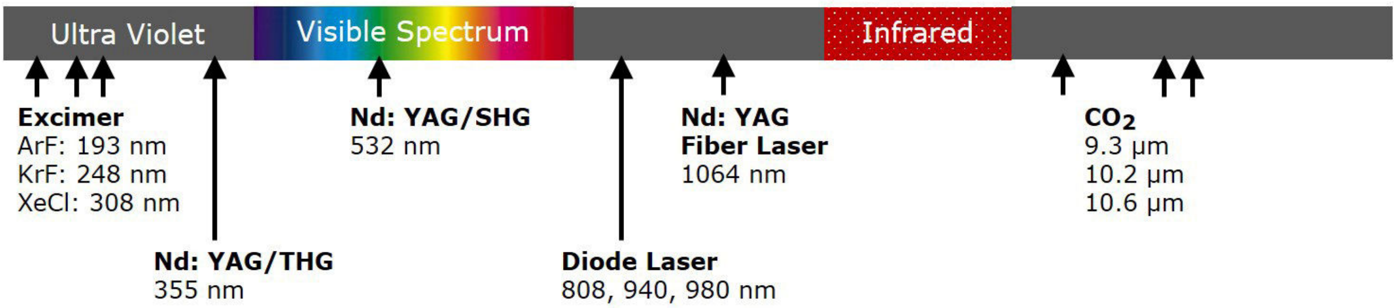
Alternate Wavelengths for CO_2 Lasers

Why Laser Wavelength Matters

Every material has a characteristic absorption spectrum—that is, there are certain wavelengths of light that a given material absorbs more readily than others. Why does this matter? Lasers produce light at very specific wavelengths. By pairing that wavelength to a material that easily absorbs it, the application results are of higher quality and the processing itself is faster.

Laser Types

One of the defining characteristics of different laser types (including CO_2, Fiber, YAG, UV, and many others) is their wavelength.



CO_2 lasers have long wavelengths, around 9.3 – 10.6 µm, with 10.6 µm as the most common. These wavelengths pair nicely with the absorption spectrum from polymers, ceramics, textiles, natural materials like paper or wood, and certain metals. By contrast, the shorter wavelength YAG or Fiber lasers tend to have better absorption in metals.

CO_2 Laser Wavelengths

Once the type of laser has been chosen, there are options to optimize the wavelength for a specific material. CO_2 lasers are typically available in three wavelengths: 9.3 µm, 10.2 µm, and 10.6 µm.

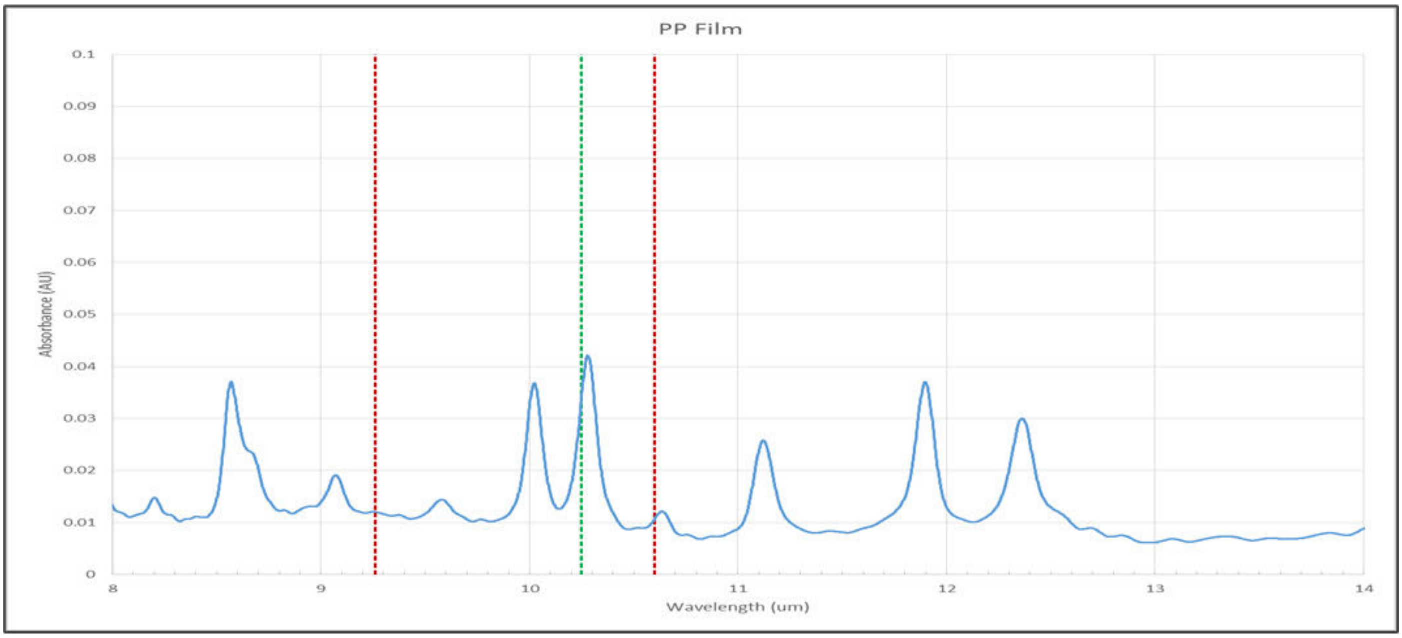
10.6 µm	• This wavelength works well for most common marking, engraving, and cutting applications. The exceptions are noted below.
10.2 µm	• **Polypropylene Films (OPP, CPP, PP),** commonly found in labels and packaging, can achieve 2.5 – 4X speed increases when cutting or perforating at this wavelength. • **Glossy Paperboard Packaging** can be marked with higher contrast at this wavelength, since the package includes a polypropylene surface layer.
9.3 µm	• **PET Plastic** comes in many forms. It is commonly used as rigid packaging (water or beverage bottles especially) and PET films are found in both packaging and as electronics screen protectors. When marked, this wavelength produces a high-contrast frosted appearance, perfect for permanent date codes or batch marking. When cut, this wavelength delivers minimal melting or heat affected zone (HAZ) along the cut edge for higher quality results. • **Polarizer Films for LCD Displays** can be cleanly cut with minimal melting or HAZ using a high peak power version of this wavelength. • **Polyimide (Kapton) Films** are commonly used in electronics. A high peak power version of this wavelength reduces the charring characteristic of this material, producing better results when cutting, drilling, or ablating.

9.3 µm (cont.)	• **FR4/FR2 PCBs** all tend to char when laser cut or drilled. A high peak power version of this wavelength significantly reduces the effect for higher quality results. • **Polycarbonate** is used across a variety of industries for its durability. A high peak power version of this wavelength significantly reduces the charring and discoloration commonly associated with laser processing this material. • **Pebax Plastic** is often found in medical tubing. This wavelength produces better vaporization with less melting when cutting or ablating Pebax.

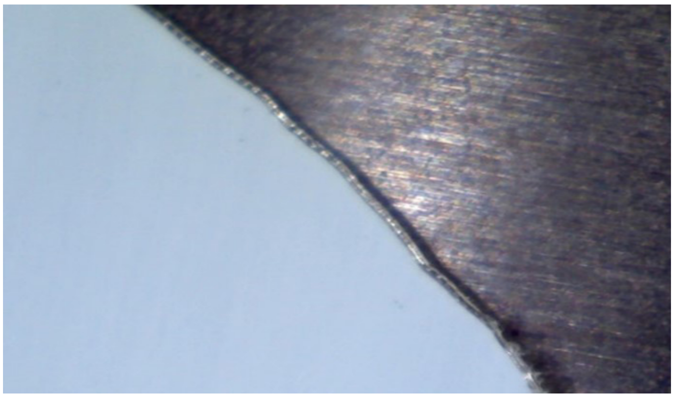
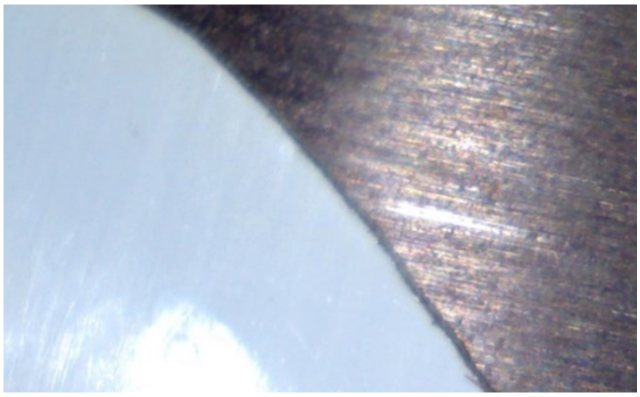
Note that while the 10.2 and 9.3 µm wavelengths excel in processing certain materials, they are also capable of processing more common materials as well. If you plan to process a variety of materials, an Applications Engineer can help select the optimal wavelength for your needs.

Application Example: Polypropylene (PP)

This is the absorption spectrum for polypropylene, with peaks indicating wavelengths with higher absorption. The two red lines represent 9.3 and 10.6 µm respectively. The green line, corresponding to a nice absorption peak, is 10.2 µm. Based on this, we expect 10.2 µm to perform better than the other CO_2 wavelengths in marking and cutting applications.

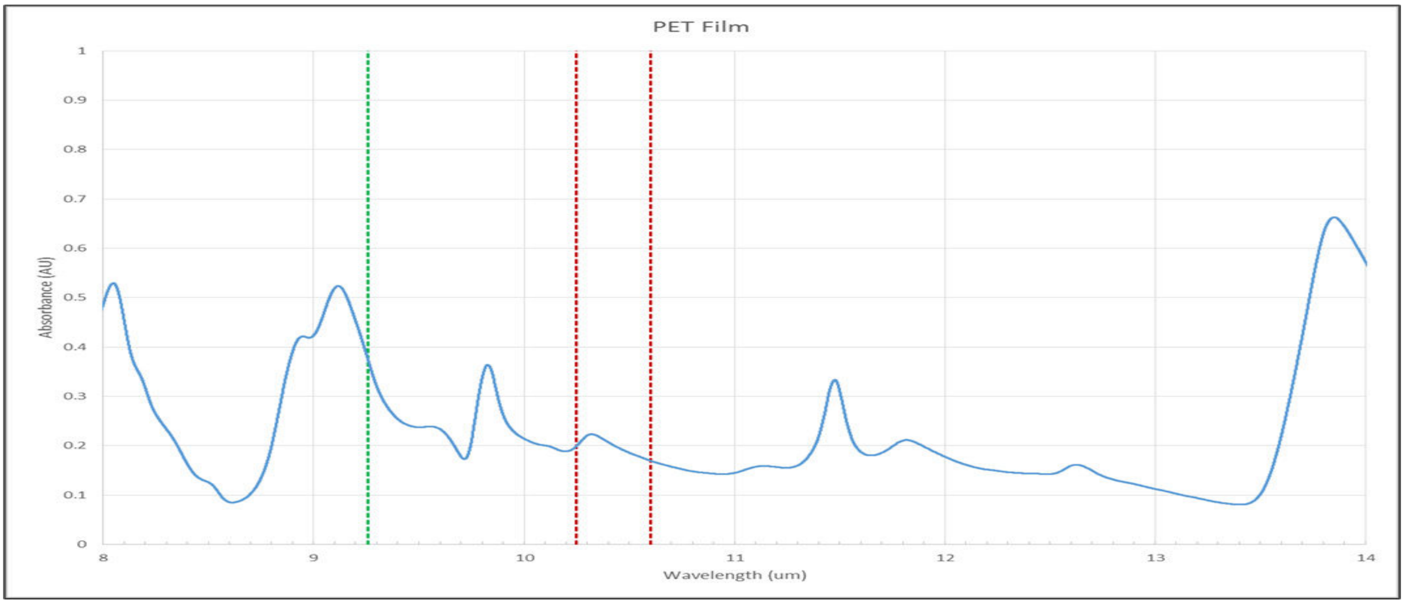


Marking Glossy Paperboard	
10.6 µm: While legible, the mark is inconsistent.	10.2 µm: Clean, consistent, and highly visible mark.
	

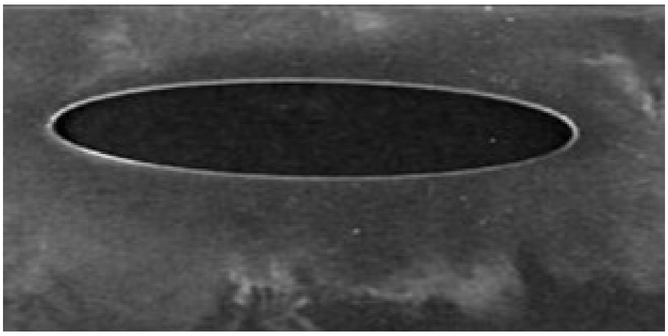
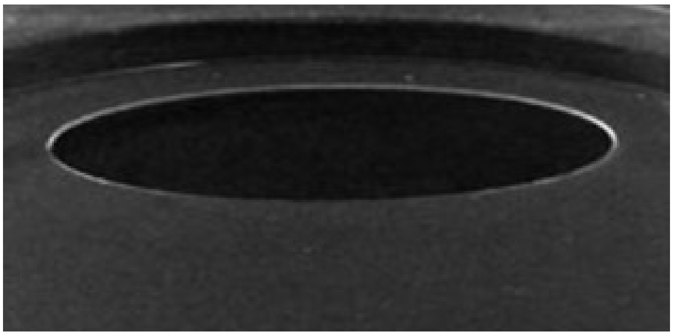
Cutting OPP/BOPP Films	
10.6 µm: Cutting produces a noticeable melt lip.	10.2 µm: Cutting is 2.5X faster, and produces a crisp edge with minimal melt lip.
	

Application Example: Polyethylene Terephthalate (PET)

In this absorption spectrum for PET, the two red lines represent 10.2 µm and 10.6 µm respectively. The green line representing 9.3 µm is positioned at an absorption peak, so we would again expect better processing at that wavelength.



Marking PET Bottles	
10.6 Qm: While legible, the mark is nearly invisible. There is also a danger of puncturing the material due to higher transmission.	9.3 µm: The mark has a frosted white appearance for better visibility. 9.3 µm also interacts at the surface of the material, minimizing risk of puncture.
	

Cutting PET Films	
10.6 µm: Cutting produces a large amount of debris and more melting at the cut edge.	9.3 µm: Cutting produces a clean edge with no residue and minimal melting.
	

Conclusion

By selecting the proper laser wavelength for the material, application results are of higher quality and can typically be processed at higher speeds. Optimizing the absorption of the laser energy is especially critical for sensitive materials, like thin films, or processes with high tolerances, like selective cutting of labels.

To determine the best option for your application, contact us to schedule an application test.

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