

【 Comparison Table of Lasers 】

	YAG Laser	Fiber Laser	Femtosecond Laser
<b>Laser source</b>	YAG crystal	optical fiber	mode locking laser
<b>Processing method</b>	<b>Heat conducting processing:</b> Laser energy absorbed on the surface conducts into a depth direction.	<b>Key hole processing:</b> Multiple reflection of laser in a key hole, made by evaporation of the laser condensing point, enables to make a deep hole.	<b>Non-heating processing:</b> The laser beam evaporates just a laser condensing spot area instantaneously so that the heat gives minimum effects to the material.
<b>Welding capability</b>	<b>Excellent:</b> Spot welding is available at low cost and high power.	<b>Good:</b> It is suitable for deep and narrow welding at high speed.	<b>Inapplicable:</b> basically impossible
<b>Subtractive process (cutting, drilling etc.)</b>	<b>Inapplicable:</b> basically impossible	<b>Good:</b> It can remove a large volume of a work at one time, but the finished quality is sometimes poor.	<b>Excellent:</b> It removes a small volume of a work at one time in a high quality, requiring a longer time for removing a volume of work.
<b>Pulse width</b>	microseconds to milliseconds	microseconds to continuous wave	femtoseconds to picoseconds
<b>Total output power</b>	<b>Middle:</b> high peak power	<b>High:</b> Continuous processing with a high power is available.	<b>Low:</b> ultrashort pulse with a high peak power
<b>Dross or Deposited</b>	(only welding is available)	<b>Dross adhesion:</b> Finishing work is required for removing dross.	<b>Dross-free:</b> (Dusts can be easily washed out.)
<b>Productivity</b>	<b>Middle</b>	<b>High</b>	<b>Low</b>

【 Features of Femtosecond Laser 】

<b>Ultrashort pulse laser</b>	One femtosecond is one petasecond, $10^{-15}$ second. (Light can travel only 0.3 $\mu\text{m}$ in one femtosecond.)
<b>Minimum thermal effect to materials</b>	<p>Much smaller denaturalized areas is provided to the vicinity of a processed point due to the less heat effects.</p> <p>Resins can be processed as well as metals.</p> <p>Materials weak to heat, e.g. one having a low melting point, are especially suitable to be processed.</p>
<b>High precision work</b>	<p>Transparent materials, even only inner parts of them, can be processed.</p> <p>Ultrashort pulse laser beam, having a strong electric field with compressed energy in time and space, causes non-linear interactions, such as multiphoton absorption and multiphoton ionization, only on a beam condensing spot.</p>
<b>Less damages to vicinity</b>	<p>Less chippings or cracks are given.</p> <p>Femtosecond laser process can be well employed for hard-to-cut materials, such as ceramics and composite materials, because it minimizes the damages to the vicinity of the processed area.</p>
<b>Processing capability to high-band-gap materials</b>	<p>Femtosecond laser process can be well employed for high-band-gap materials, e.g. glass or particular polymers, because the ultrashort pulse laser absorbs a large number of multiphotons.</p> <p>Transparent materials are processed from the bottom side, and the higher transparency gives higher productivity.</p>