

Application Note #12

Deep Engraving with Fiber Lasers

Introduction

Laser engraving is a non-contact process to ablate materials by vaporizing them to achieve a controlled depth with a high quality finish. Laser engraving is economical and produces more detailed artwork, text or graphics compared to mechanical engraving. Advantages over the mechanical process include substantial reduction in setup costs, process time, fine detail engraving and the ability to engrave on curved surfaces. Popular applications for laser engraving include making molds, engraving of jewelry and engraving tracking numbers in parts to be used in rugged environments. Most materials including steel, aluminum, ceramics and highly reflective gold and silver are laser engravable; processes have been adapted for engraving mold cavities, jewelry, industrial, automotive and aerospace components. Machining depth of 0.001”-0.25” can be easily achieved with minimal taper of the side walls.

Q-switch Lasers

The 1 mJ 20 W YLP laser has been widely used for marking and engraving applications. The 1 mJ, 50 and 100 W high average power lasers are ideal for deep engraving applications as these lasers substantially reduce the cycle time over lower wattage lasers. The 50 and 100 W YLP fiber lasers offer peak power of 10 kW and can be pulsed up to 200 kHz; pulse width is 100 ns with beam quality (M^2) of 1.5. IPG’s Q-switch lasers are also equipped with a heavy duty optical isolator that eliminates back reflections and improves output pulse stability.

WELDING APPLICATION

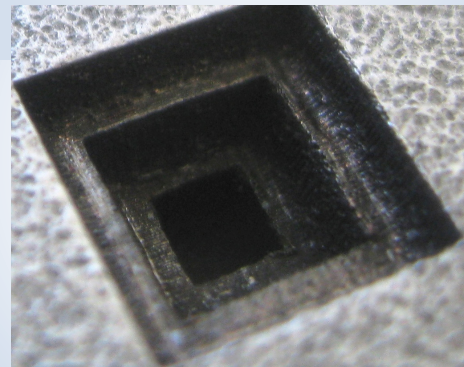


Figure 1: Engraving in Sic (top), Steel (bottom) and Ablation of TBC Coatings (center)

Engraving to a certain depth can be achieved in a number of ways. Parameters such as frequency, pulse overlap and peak and average power are chosen depending on the type of material and material thickness while factors such as engraving depth and surface roughness influence parameters as well.

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TTLW for Continuous Fiber Composites

At lower average powers, the quality of the engraving is finer and more controlled but the process will be extremely slow, versus at higher powers, the engraving is not as fine and process is significantly faster. Techniques using a combination of higher and lower power settings will achieve optimal results with the higher power lasers.

Engraving tests were performed on a variety of materials from 20 - 100 W, with 1 mJ pulses and based on data gathered a rough estimate of volumetric ablation rates are presented. These numbers can vary depending on optical configuration, laser settings, scanner delays and software settings, etc. Another trial using the YLP-HC 50 W laser has measured removal rates as high as 6.25 mm³/s. There are many different scanning techniques to achieve the best combination of material removal and finish quality and almost every laser user has their own approach.

An engraving system with proper software capabilities can achieve a variety of engraving configurations such as positive and negative 2-D and 3-D with layering with high quality with the fiber lasers. The YLP lasers have been implemented in production for deep engraving applications such as serializing hand arms, ablation of thermal barrier coatings, engraving on jewelry, rings and metals and components used in rugged environments.

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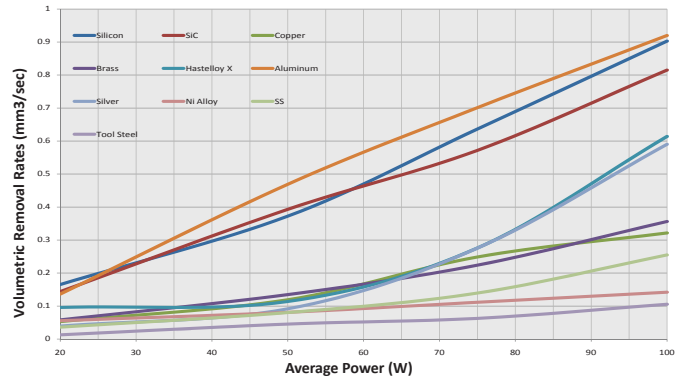


Figure 2: Ablation Rates of Different Materials

Summary

The 1 mJ YLP Series of pulsed fiber lasers is designed to be easily integrated into an OEM application such as 2-D and 3-D deep engraving machining systems. These lasers deliver high peak power (up to 10 kW) and high average power (up to 100 W) with 100 ns pulse duration. The increased power levels allow end users to achieve faster ablation rates and make the process more efficient. These lasers embody all of the advantages of IPG's fiber laser technology including ultra reliable pump diodes, compactness, high efficiency and reliability at a very competitive price. The factory sealed YLP lasers are robust, maintenance and service free and requires no consumables.

IPG looks forward to helping our customers with their laser applications and future plans. IPG supports well equipped and professionally staffed applications laboratories; contact IPG to arrange free sample evaluation or process development or go to www.ipgphotonics.com for more information.