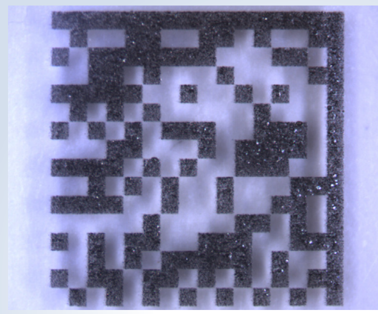
Application Note #9

Laser Marking of Polycarbonate with Short Pulse Low Nanosecond Fiber Lasers

WELDING APPLICATION



YLPM-1-4x200-20-20
25 kHz, 20 ns, 0.6 m/s

Figure 1: 10 mm Square 2D Matrix in Polycarbonate

Marking Parameters	
Marking Speed	0.5-1 m/s
Laser Power	6 w
Scan Lens	163 mm
Repetition Rate	25 kHz
Pulse Duration	20 ns
Raster Fill	28 µm

Introduction

Fiber lasers have made a serious impact in many industrial laser applications. This is particularly true in laser marking. The improved performance, increased reliability and reduced cost of ownership of fiber lasers is now almost universally accepted. IPG's range of compact laser marking modules extends up to 50 W average power for deep marking and engraving metal at high speed. This high power is available without any reduction in focusability of brightness. For marking polymers, however, a 20 W average power laser is usually able to achieve very high marking speeds. The uses of polycarbonate are expanding for items such as lenses due to its extreme toughness and its excellent optical properties. The demand for high quality laser marking of polycarbonate parts has also increased and this has now become a standard process for many different industries.

Laser Marking of Polycarbonate

The mechanism that produces a contrasting visible mark in polycarbonate is rather different from the mark produced by lasers in other materials. Under certain laser conditions, infrared laser beams are not immediately absorbed at the surface of clear or lightly colored polycarbonate and polycarbonate type materials but they are absorbed in the upper layers of the material. This controlled absorption produces small nodules or bubbles within the material, sometimes to a depth of as much as 0.2-0.3 mm. Close examination of these tightly packed bubbles shows many of them to be sub-micron in size.

If we assume that absorption of the laser beam by the part is constant, then the heat input to the part is controlled by the average power of the laser, the translation speed and if a rastering technique is used, the raster fill or pitch. Increasing power, decreasing raster fill and decreasing mark speed all increase heat input to the part. When marking polycarbonate type materials, this appears to enlarge the bubbles which then agglomerate and typically break the surface of the part. The skill in laser marking with infra-red fiber lasers is to balance these input parameters to achieve a dark mark and excellent visible contrast without roughening the surface to a large extent. See Figure 1 (above).

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Summary

To achieve visible contrast, laser marking of polycarbonate type materials relies on a different mechanism from that found on other polymers. The controllability of nanosecond fiber lasers allow high quality and high contrast laser marking of clear polycarbonate at high speed. In polycarbonate, the marks can be largely subsurface.

There are several lasers within IPG's range that are capable of making this type of mark, the laser selection is based on whether the flexibility of a variable pulse length is required or not. For the best quality marks, the IPG YLP-M 1-4x200-20-20 variable pulse length laser should be used. Because of variations in the degree of crystallinity and hence absorption of IR radiation in polycarbonate, scanner delays and dwells will almost always need to be optimized for a particular component. The compact desk-top system shown below in Figure 2 is ideally suited for this type of specialized laser marking process.

Figure 2: Mecco's Marking System Utilizing IPG's Fiber Laser

IPG looks forward to helping our customers with their marking applications. Contact any of IPG's application facilities to arrange free sample evaluation & process development. Go to www.ipgphotonics.com for more information on all of IPG's products.

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