Fiber Laser Marking of Plastic: Polycarbonate

Introduction:

Polycarbonates are a particular group of thermoplastic polymers. They are easily worked, moulded, and thermoformed; as such, these plastics are very widely used in many modern industries. Their interesting features, such as temperature resistance, impact resistance and optical properties, position them between commodity plastics and engineering plastics.

Products such as drinking bottles, baby bottles, mugs, bowls, wall sockets or dimmers, iMac shells or iPod cases, medical syringes or medical tubes are made out of polycarbonate. Such a plastic is extensively used in a wide range of products from several sectors such as the electronic, medical, packaging, or chemical industry.

Figure 2: Marking graduated marks on the syringe barrel

Manufacturers require marks so as to be able to identify each and every product coming out of the production line which can be typically approximately in the range of 1000 units per minute and therefore, a high speed marking method is required. On top of that, with the urge to have indelible marks, manufacturers are now switching from the traditional ink marking to laser marking.

Marks, such as graduated marks, indicating the volume of fluid are of prime importance in both the packaging and medical sectors. Such marks allow the user to measure the quantity of liquid being poured in the product.

Benefits of Laser Marking:

Lasers offer some clear advantages over alternative technologies as they provide a non-contact, consistent marking process that produces indelible marks. Marking systems are easy to operate with no tooling requirements. All of the marks are software programmed and typically made with CNC controlled scanner mirrors that are capable of line marking speeds up to 6m/s, which equates to nearly 1,000 characters per second. The beam is focused onto the surface of the material to be marked with an F-theta lens which ensures the beam is consistently focused over a working marking area. The spot size of the beam can be as narrow as 25 microns and moved with micron precision.

For many polymeric materials, high pulse energy is not often required to make an acceptable mark and in fact can prove to be detrimental. An example where this applies is when marking some ABS type materials, where high pulse energies produce marks with good contrast but unacceptable roughness. Using lower pulse energy but a higher repetition rate achieves an equivalent average power, smooth surface marks but with the same contrast – only SPI's fiber laser can offer high repetition rates with low pulse energy up to 500 kHz.

SPI Lasers' MOPA Fiber Laser:

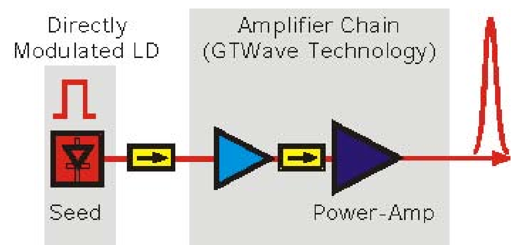

Figure 3: Basic MOPA system architecture

The recently introduced pulsed fiber laser uses a MOPA (Master Oscillator Power Amplifier) architecture, (Fig. 1), which uses a directly modulated seed laser that is amplified using a proprietary fiber laser based amplifier chain. This in turn allows the pulse parameters to be more effectively controlled.

This design enables high peak powers that are not achieved with standard modulation. Peak pulse powers in excess of 14kW can be achieved at 25 kHz with an average output power of 20W. The unit also has a high pulsing frequency range from 1-500 kHz and with pulse widths in the 10-200ns range. The laser is also capable of working in continuous wave (CW) mode.

The MOPA arrangement allows control of the

pulse shape, duration using a range of preset pulse waveforms are available as shown (Fig. 2) below. This flexible control over pulse width and peak power with the *PulseTune* function enables very high repetition rates whilst maintaining relatively high peak powers.

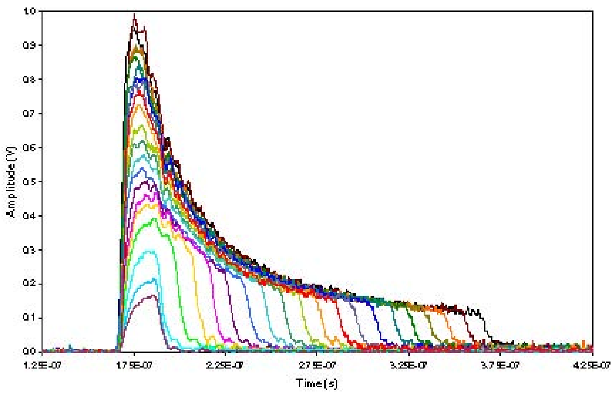

Figure 4: Pulse wave forms showing range of pulse energies 0.04mJ – 0.8mJ

Parameters for the SPI Fiber Laser:

Marking of polycarbonate may also be known as foaming (refer to the Plastic Marking Application Note for more details on Foaming).

To reach an excellent mark on Polycarbonate with an SPI laser, the laser should be set at a full power of 20W. Wave-form 3 (250 kHz) at a speed of 4 to 5m/s provides an excellent and nice contrast of foaming mark.

Benefits of SPI's Fiber Lasers:

- Significant improvement in the quality of the mark due to the stability and controllability of the laser source.
- Beam intensity and spot size enable the use of small mark widths.
- Output power stability over time enables complex mark patterns without power fluctuations - no weld defects.
- High power density allows large marking areas to be processed rapidly.
- The high beam quality of a fiber laser allows for the use of a long focal length lens. This in turn gives a greater depth of focus and so allows greater tolerance to piece part distortion.
- Maintenance free (no replaceable parts).

- No thermal lensing, no alignment or calibration required.
- Robotic mounting of the fiber laser allows the beam to access hard to reach areas.
- 3-Dimensional marking can be easily achieved.

20W Pulsed SPI Fiber Laser

For further information & to register for your FREE 30-day SPI Fiber laser evaluation unit, please contact the following BFi OPTiLAS offices:

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