Fiber Laser Marking of Plastic: ABS

Introduction:

ABS, Acrylonitrile Butadiene Styrene, is a common thermoplastic used to make light, rigid, moulded products such as wall sockets, keyboards etc. Many industries use ABS in a wide range of products due to its mechanical properties which are good for impact resistance even in low temperatures. The material is stiff, and the properties are kept over a wide temperature range.

Since ABS is extensively used in products requiring user interaction such as the keyboard, graphics/symbols are needed to communicate what the functions, of the different parts of the product, are.

• The marking of letters/numbers on keyboard buttons.

Figure 1: Keyboard

• The marking of paper sizes so as to indicate where to place the paper in a paper tray of a printer.

Figure 2: Printer Tray

• The marking of a fuse box cover to provide a clearer image of the layout, current ratings and protection information.

Figure 3: Car Fuse Box Cover

• The marking of a laminator body to indicate the temperature levels to be used for the different types of document pouches.

Figure 4: Heating levels marks on the shell of a Laminator

• ABS Pipe Industries require pipes to be marked, with indelible marks such as the pipe size, the manufacturer's name or trademark, etc.

As it may be seen from the list above, ABS is widely used is different industries, and laser marking has proved itself very rapidly in these industries.

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:

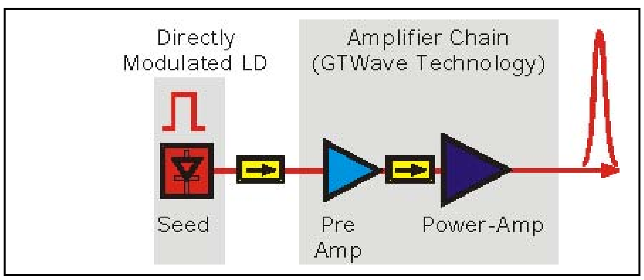

Figure 5: Basic MOPA system architecture

The recently introduced pulsed fiber laser uses a MOPA (Master Oscillator Power Amplifier) architecture (Figure 5) 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 (Figure 6) 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.

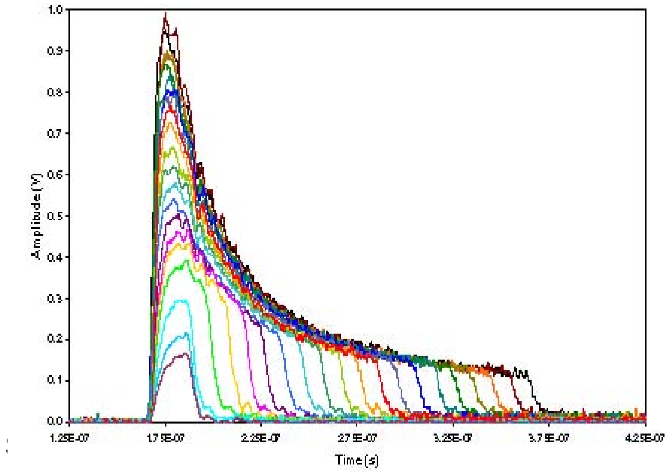

Figure 2: Pulse wave forms showing range of pulse energies 0.04mJ – 0.8mJ

Applications Lab in the US, and from the results obtained the Q-switch laser produced rough marks at 3m/s. The quality of the mark could be improved only if the power is turned down with no increase in the marking speed.

High contrast dark marks were obtained with the SPI fiber laser at a speed of up to 3.5m/s with an average power of 20W. With a very fine tuning, smooth surfaces and good contrasts can be achieved and the surface texture varies with speed, power, and frequency (see Figure 6 for the different waveforms or frequency levels achievable with the SPI fiber laser). A high scan speed and a correct raster scanning are both necessary to avoid re-melting and reduction in contrast.

Parameters for the SPI Fiber Laser:

For the engraving of ABS, such as in the marking of the printer tray, low waveforms are used (55 kHz to 65 kHz) at a full power of 20W.
To mark ABS with a colour change, as in the marking of the keyboard or the laminator shell/body, wave-forms 3 and 4 are used (250 kHz to 375 kHz) at a full power of 20W. The speed achieved for this particular application is in the range of 3 to 4 m/s.

SPI Lasers inspiring your products & manufacturing

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 mark defects.
- High power density allows large marking areas to be processed rapidly.
- Maintenance free (no replaceable parts).
- 3-Dimensional marking can be easily achieved.
- High repetition rate is achievable.
- Low frequency (<20 kHz) – control of heat input; processing of thermally sensitive plastic can be controlled (increase in heat might cause the plastic to melt).
- Low M² - the depth of field is high.

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20W Pulsed SPI Fiber Laser

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