Fiber Laser Marking – Night & Day Mark

Introduction:

The Night and Day marking application, also known as paint removal, is a very demanding application in various industries such as in the design of a car's interior.

Research is continuously carried out into improving the cockpit environment for a car's occupants. The effective nighttime illumination and daytime aesthetics of a car's interior are becoming more important (see Figure 4 and 5). Switches and panels can be painted and lit in a variety of colours and use is being made of halo lighting and concealed graphics that only appear when illuminated. As people become accustomed to smaller buttons, steering wheels are being designed to include more of the controls for in-car entertainment, phones and cruise control.

How is the process carried out?

A transparent polymer substrate, such as ABS, is used since it allows light to pass through. A layer of paint (of any colour) is sprayed on the material (see Figure 1 and 2) which is then mounted on a laser system. As shown in Figure 3, the layer of paint is removed by the laser in such a way that the back-light, when switched on, will allow the user to see the graphic, sign, or symbol (see Figure 4 and 5).

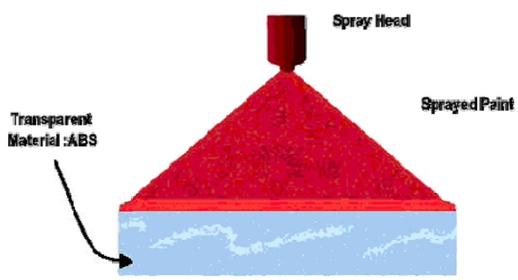

Figure 1: Applying a layer of paint.

Figure 2: Layer of Paint resting on the transparent material.

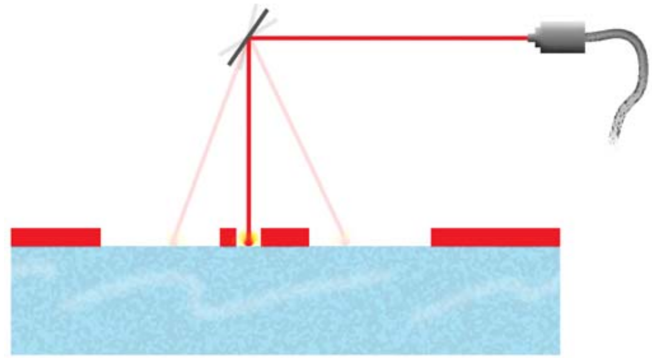

Figure 3: SPI's Laser at work - removing parts of the paint layer.

The laser beam is projected on a computer controlled mirror (galvo mirror) which in turn projects the beam to the desired surface.

Night and Day marking allows the user to see the graphic both in day light and at night time with back illumination, as shown below.

Figure 4: Car switches

Figure 5: Illumination of a Speedometer

SPI Lasers' MOPA Fiber Laser:

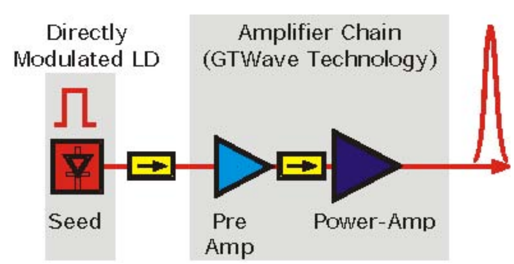

Figure 6: Basic MOPA system architecture

The recently introduced pulsed fiber laser uses a MOPA (Master Oscillator Power Amplifier) architecture, (Figure 6), 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 7) 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.

Tests carried out at SPI's Apps Lab:

It has been demonstrated that a dual-pass laser technique gives excellent result with an SPI fiber laser.

A first pass, at relatively high pulse energy, and a second pass, at a lower pulse energy and higher repetition rate at 250 kHz and 3 m/s speed, produce the best combination of speed and quality. A high repetition rate is used to attain

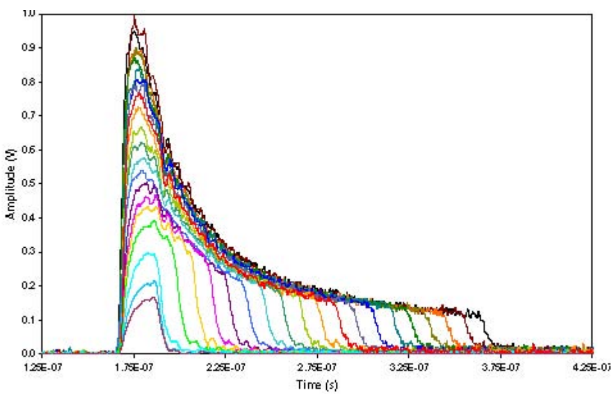

Figure 7: Pulse wave forms showing range of pulse energies 0.04mJ – 0.8mJ

best process control. A multi pass method at high speed, around 2-3 m/s, helps to avoid the damaging of the substrate (Figure 9).

On the SPI nanosecond pulse laser, a simmer current feature enables a very rapid rise time, where the first pulse height can be approximately 75% of the steady state value. This produces clean crisp sharp edges to the characters. The human eye is remarkably sensitive to micron level changes in features because of the high contrast produced by the backlighting.

Figure 8: No Backlight

Figure9: Multi pass 3X a t 500Khz,10ns,10W,301000mm/s

When carrying out the experiment with an YVO4 (Neodymium-doped Yttrium Vanadate) laser, it was seen that average power was lost at 200 kHz; reduction in productivity occurs.

Parameters for the SPI Fiber Laser:

To achieve an excellent Night & Day mark, as shown in Figure 10 & 11, a high repetition rate of 250 to 500 kHz at 3m/s speed and full power of 20W should be used.

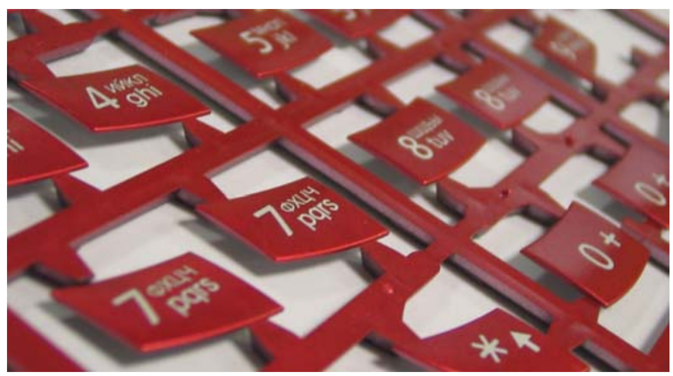

Figure 10: Keypad Buttons

SPI Lasers

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Figure 11: Silicon rubber cell-phone keypad

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20W Pulsed SPI Fiber Laser

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.

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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