MEMBERS' NEWS

Selecting a scan system for laser processing of plastics

Mark Drechsler, Scanlab AG

To achieve optimal results for laser plastic material processing in combination with scan systems, the application requirements such as the working field size, spot diameter/power density, as well as dynamics and precision must be defined. Having fixed these values, the laser process parameters such as wavelength, power, pulse energy and duration are specified by the process itself. With these parameters the scan head, mirror coating and objective focal length can then be chosen to meet the requirements.

In the following examples, the scan system configurations are analysed for three typical applications for laser (plastic) material processing.

Laser marking

Laser marking remains the most common application for scan systems. Scan heads with small apertures (7 to 14 mm, shown in figure 1) achieve the highest marking-speed with well over 1,000 characters per second. Lasers with power levels in the range 5 to 100 W are used with these scan heads. A typical focal length of 160 mm allows spot diameters smaller than 40 µm ($1/e^2$) for a 1064 nm laser with an M^2 of 1.2 in an image field of approximately 110 x 110 mm.

Laser micro structuring

Laser micro structuring is already an important application and continues to gain significance with the ongoing miniaturization of consumer electronics. Processed materials could be PCB boards, Mylar, Kapton etc.

Such applications require high beam quality and often lasers in the UV range (e.g. frequency tripled DPSS). To take full advantage of the laser performance, a typical set up will comprise a scan head with high-performance mirrors (in respect to flatness and reflectivity) and a telecentric f-theta objective of short focal length. In this way a minimum spot diameter and heat affected zone (HAZ) can be achieved. Such scan system configurations usually result in an image field size of approximately 50 x 50 mm with an angle of incidence close to 90°.

Figure 1

hurry*SCAN*® 10 and *SCAN*cube® 7 & 10

With the excellent beam quality of today's UV lasers ($M^2 < 1.2$) spot diameters of less than 10 µm ($1/e^2$) are possible. Beside small spot diameters micro machining applications demand high overall accuracy. A typical machine is based on a vibration isolated granite structure. Laser, scan system and, if required linear stages are integrated into this structure.

To obtain ultimate long-term stability Scanlab offers optional sensor systems for automatic self-calibration with most scan heads. Customized heads (e.g. for micromachining applications) are also available.

Laser 3D surface treatment

Laser 3D surface treatment illustrates the use of an additional dynamic Z-axis, called vario*SCAN*®. In combination with a 2D scan system the laser spot can be positioned within a process volume by using XYZ-coordinates (see figure 2).

A typical configuration for 3D surface treatment might include (in addition to the vario*SCAN*® and the 2D scan head) a 1064 nm laser with an $M^2 \sim 10$, and an f-theta objective (typical focal length 254 mm), providing a spot diameter of approximately 0.5 mm ($1/e^2$) within a working volume of 170 x 170 x 80 mm³.

Typical applications include 3D MID (Molded Interconnected Devices) and quasi-simultaneous laser plastic welding. This particular set-up is also applicable to many non-plastic 3D processes.

Calculating the spot diameter:

The formula below links the spot diameter *s* to the focal length *f*, the laser wavelength λ, the laser beam quality M^2, a correction factor *k* (ideal value would be 1.27, real values are usually between 1.5 and 2) and the free aperture of the scan head *a*.

$$s = \frac{f}{a} \times \lambda \times M^2 \times k$$

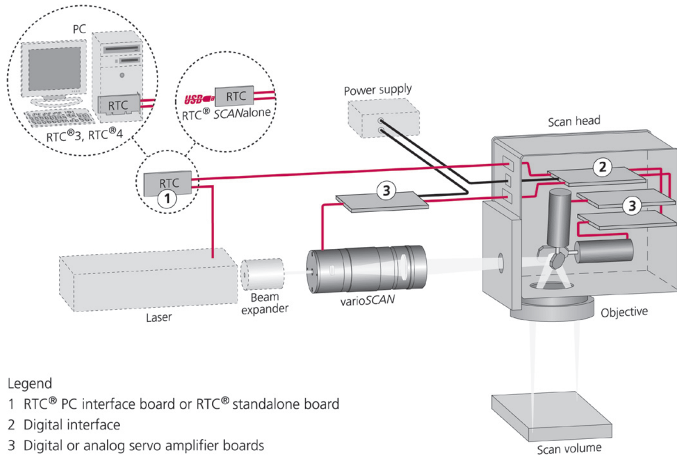

Figure 2. Possible scan system configuration

Although the ultimate, all-encompassing scan system may be the goal, the fact that the individual parameters are linked together means that an optimum solution will require compromises. Helpful information and guidelines how the scan head configuration is determined by the application requirements can be found at *www.scanlab.de*.

Summary

Laser material processing with a galvanometer-based scan system is attractive to the industry because of its versatility, flexibility and high throughput. Such laser machines can be easily adapted to new requirements by modifying the process parameters (e.g. speed, laser power, repetition rate, focal length, spot size, etc.).

As briefly introduced in this article scan systems are used in a wide range of laser plastic (and non-plastic) material applications. Trends in consumer markets lead to new products that are smaller and more powerful and must be produced at lower cost. As laser based systems are very well suited to do that job even more demanding applications will arise.

Scanlab´s intelli*SCAN*®, based on the new *iDRIVE*® technology (digital servo amplifiers) and new control boards, offer additional features. Real-time monitoring of all important system status parameters, such as position, speed and amplifier current as well as new remote-diagnosis possibilities for system integrators and more will be available.

Contact:
Mark Drechsler
SCANLAB AG
T: +49 (89) 800 746-240
E: m.drechsler@scanlab.de