Diode Lasers in Mass Production

Flexible Welding Technique

Up to now available laser light sources have been too complex, too big and too expensive for welding plastics. However, in this regard modern diode lasers are exceptional: They are compact, efficient and ready for use in industrial mass production.

Laser welding of plastics offers advantages compared to other joining techniques. Laser welding is a non-destructive non-contacting process with well controlled local heat application. The heated up zone is minimal. High welding temperatures can be achieved and they can be applied very precisely. The laser does not cause vibration and therefore no abrasion in the components.

The Welding Procedure

Basically, one differentiates between butt joint and transmitted light welding. In the butt joint procedure the energy is brought to both parts at the same time. It is limited by the penetration depth of laser radiation. In the transmitted light procedure, however, the energy is brought through the first IR transparent part into the second absorbing material.

Welding Strategies

In contour or track welding the laser radiation is focused on one point. The laser and the work piece are then moved relative to each other. It is possible to deal with 3D-contours.

For simultaneous welding several laser light sources are arranged along the desired welding contour. The entire contour is heated up at the same time. However, arrangement of many lasers along the contour is complex. This strategy is not flexible and limited to relatively simple geometries.

A promising alternative is quasi-simultaneous welding. Also here the contour is traced out with a focused laser beam. However, this is done using a fast mirror deflection system without having to move the laser or the work piece. The goal is to trace the contour several times so fast that the cooling process is relatively slow and the contour is melted practically evenly. This procedure is very flexible. Contour geometries can be changed quickly by modifying the program.

Diode Laser Tools

The laser system FLS iron (manufactured by Fisba Optik, St. Gallen/Schweiz) has a very robust, compact design that fulfils the needs of the user regarding ease of integration and immunity to disturbances. Usually a CCD camera for process visualisation and regulation of the production process in the work station is integrated into the laser head. Frequently an automatic control loop is essential for stabilising the process since in plastics welding the process window is relatively narrow and the difference in temperatures between melting and decomposing the material is relatively small. A special pyrometer measurement head was developed for the FLS iron type laser. In many

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cases the temperature of the melt can be measured on-line without contacting it. The first standard scanning system for high performance diode lasers was presented recently. The very good beam quality of the diode lasers made it possible to provide fast beam deflection with FLS iron. This makes so-called quasi-simultaneous handling of more or less complex geometries possible.

Summary and Perspective

Already numerous welding experiments have been carried out on very diverse standard and high temperature thermoplastics. For polyamides the first systematic investigations sometimes showed extremely high strength welded joints. Laser welding of plastics is in a phase of industrial introduction and is slowly finding more and more users. The laser tools have been developed to a large extent. However, so far there are hardly any complete standard systems. Usually systems are specifically adapted to actual production needs in order to fulfil high throughput and quality requirements.

Fig.: High performance diode laser with deflection head