



Ergonomic workplace design
through to program operation

For Ultra-fine Welds

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Plastics are playing an ever more important role in microscale applications such as the production of chips, sensors and electric devices (Fig. 1). The tinier the elements to be processed, the greater is the problem of joining them precisely to one another. To join highly sensitive parts of these dimensions precisely without damaging or deforming them, a novel processing technique had to be developed. This method subsequently had to be implemented in machine concepts that, thanks to precise and reliable control technology, make industrial scale manufacturing possible.

Laser Solutions on a Microscale

The recent special machine developments in plastic welding include laser systems from Leister AG, Sarnen/Switzerland (type: Novolas) (Fig. 2). These system offer a process-optimised solution for joining plastic elements on a microscale.

Conventional joining methods cannot satisfy the demands made by the ongoing miniaturisation of plastic devices. The



Fig. 1. The tinier the elements to be processed, the greater is the problem of joining them precisely to one another: microfluidic part = 20 mm x 10 mm x 3 mm (channel amplitude 0.2 mm)

mechanical and thermal stresses acting on the part to be joined and its surroundings are so high that intolerable deformations occur or unsightly beads form at the weld seams. With laser welding on the other hand, the energy required to melt the material can be introduced directly at the welding point, and it is only there that the beam is transformed into heat. The heating zone therefore stays at a minimum, as does the mechanical stress caused by the welding pressure.

With laser transmission welding, for example, the laser beam is transmitted through the upper transparent joint part and completely absorbed by the part beneath it. The radiation is transformed in-

Machine Control. Micro-scale applications require extreme precision in laser transmission welding. The laser tool axis control must operate with corresponding accuracy and reliability.

to heat locally, and the plastic melts. The transparent plastic obtains the heat required to melt it directly at the weld point by thermal conduction from the dark plastic. This process has a variety of advantages:

- minimum thermal stressing of the weld parts;
- no tool wear, since welding is contact-free;
- vibration free processing without releasing particles;
- high precision and strength.

Precise Weld Geometry through Precise Path Control

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Transmission welding is used in various geometrical processes. In contour welding, for example, a spot laser beam moves along a freely programmable welding



In Profile

Leister Process Technologies develops and produces plastics welding equipment and hot-air welders in all performance classes – from complex industrial applications to units equipment for tradesmen at its sites in Sarnen and Kägiswil/Switzerland. The customers come from almost all manufacturing industries: from automotive and mechanical engineering, via medical technology, chemicals and pharmaceuticals to microtechnology and electronics.
www.leister.com

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curve. In mask welding, on the other hand, a linear laser beam moves transversely across the parts to be welded. The beam only impinges on the joint surface at the point to be welded, since all other areas are masked off. The mask allows ultra-fine structures on a micron scale to be reproduced. Almost invisible weld seams just 100 µm wide are feasible, as is the welding of finely structured planar parts.

Thanks to the high geometrical precision and quality of the weld seams, the Novolas systems facilitate the use of plastics in all areas of precision machining, such as microsystems technology, electronics and sensors.

The precision of laser transmission welding is virtually only obtained if the controls of the laser tool axes operate precisely and reliably. Leister contracted Eckelmann AG of Wiesbaden/Germany to develop a CNC control concept appropriate to the demanding process. A proven path control (type: E. PNC55) is used. All the CNC functions with the required machine and drive interfaces are mounted on a short PCI card with a 32-bit processor of the PowerPC family. The range of uses extends from simple point-to-point (PTP) positioning tasks to 3D path control. The path control, as a new CNC solution, contains all the advantages of commercial CNC control in an intelligent and attractively priced PC card. For special machine models without path control, Leister uses a programmable logic controller in PC card format (type: PLC55, manufacturer: Eckelmann).

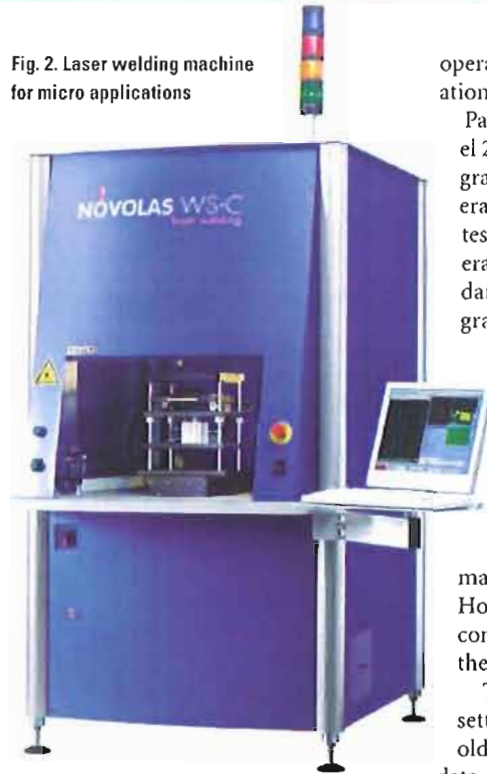
User Ergonomics thanks to Customisation

The performance of this processing method not only has to be supported at hardware level by a path control of adequate precision. For the advantages of transmission welding to boost productivity, the human/machine interface – from machine setting, through parameter input to operation – must be ergonomically optimised (Title photo).

One of Eckelmann's chief development aims was therefore the implementation of the user interface precisely specified by Leister. The user interface of the PC-based CNC runs on standard Windows systems, and was written in Delphi5. Instead of the tradition subdivision of the program modes (operation, programming and parameterisation/service) hierarchical operator guidance was realised on three levels.

With the machine start, after loading of the firmware, operator level 1 is called

Fig. 2. Laser welding machine for micro applications



and the most recently used process parameters (such as laser setting, welding temperature, welding pressure) and the most recently selected welding program (contour program) are loaded. Processing can start immediately without further input if desired. The visualisation of level 1 shows all the process-relevant parameters, such as status display (PLC), program number (path record), laser power, welding temperature and possibly warning information. User input is necessary for choosing welding programs and manual modification of power and tool speed, as well as the choice of the higher operation levels 2 and 3. The above-described automatic initialisation of the machine

operation makes routine machine operation easier and faster.

Password protection at operation level 2 allows generation of welding programs (contour programs), manual operation of the machines, and input and testing of technical parameters. To generate the contour programs, the standard DIN editor (ASCII editor) with graphic contour display is used. This proven tool, which has been repeatedly optimised in many applications, provides convenient graphical support, such as zoom, rotation and moving of contour regions and a sophisticated interplay between text and graphic mode (record selection by marking within the graphic display). However, it is also possible to read-in contours in other formats and process them as a DIN program.

The third operation level is used for setting and service purposes. Threshold values are input here and machine data can be edited. The extensive history function (trace, error and warning log-book) is available at this level.

Operator and Technology-specific Adaptation

To gain acceptance by the end customer, at least two factors must be successfully realised. The machine control must be adapted to the typical ergonomic needs of the operator, and must not fall outside the price/performance ratio of standard components as a result of extensive custom developments.

The strategy followed by Eckelmann AG, who has responsibility for the controls, was to adapt its existing self-developed hardware and software components to the end customer's individual circumstances. These house standards are designed so that the necessary adaptations are made with a minimum of development work. In addition, early and thoroughgoing communication and discussions with the machine designer and end customer are necessary. This is the way to produce cost-effective, user-specific solutions based on in-house hardware and software standards. ■

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!	In Profile
<p>Eckelmann AG, Wiesbaden/Germany, is a specialist in applications specific control solutions. It has applications know-how in laser machining and possesses the necessary in-house hardware and software modules to implement challenging path controls and motion-control applications. Through close cooperation with machine manufacturers and control manufacturers, it produces solutions matched to end customers' needs as regards process technology, machine performance and user ergonomics. Eckelmann employs 200 staff and made sales of EUR 26 million in 2004.</p> <p>www.eckelmann.de</p>	