

Efficient laser welding systems for battery production

Welding solutions for battery module production require precision, flexibility and a high level of automation

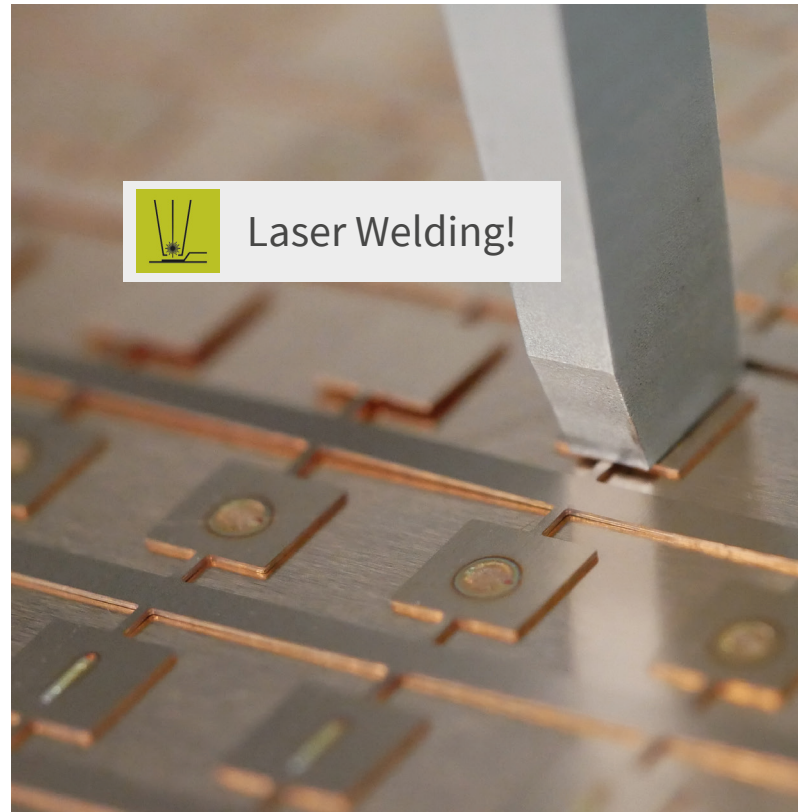
► In today's industrial automotive and electronics manufacturing, precise, automated and standardized welding solutions are essential. This applies in particular to battery module production which is a key application for high-level laser welding systems. The latest systems offer an innovative combination of features tailored to the specific requirements of these production processes. These primarily include a high degree of automation, significant flexibility for product variants and tolerances, and seamless integration into connected production lines.

Zero-defect tolerance

At the core of this technology is quality compliance. In the classic quality triangle of cost, time, and quality, quality and cycle time are often in conflict when it comes to laser welding systems. This is because the processing of cell

contacts can be done locally at the level of each individual contact or using large laser optics at the module level (remote laser welding). Despite the apparent speed disadvantage, manufacturers are increasingly choosing to weld each contact point individually. This approach not only includes the welding process itself but also incorporates time for detecting and approaching the position, bringing the joining partners into contact with defined forces and travel paths, and controlling individual parameters during welding. Material, surface, and process properties can be much better considered, significantly expanding the possibilities for quality control.

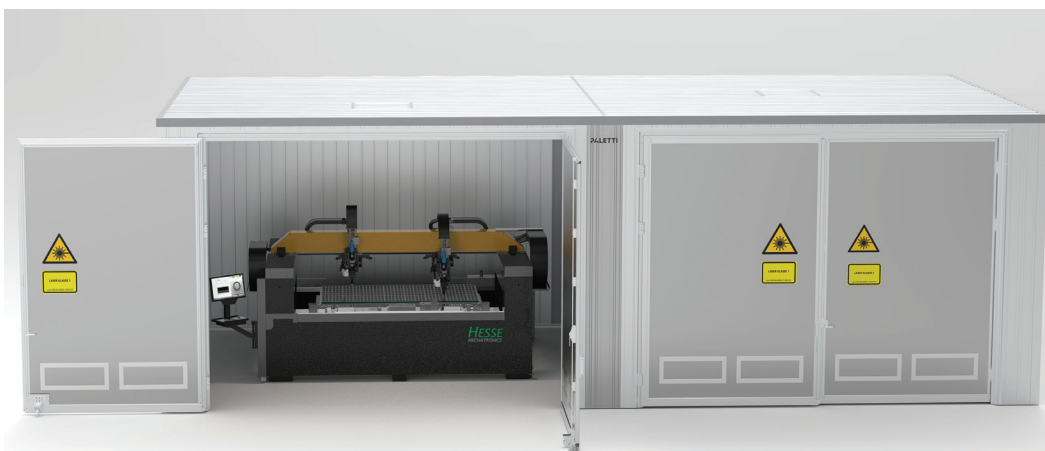
Such a system uses a welding head with integrated scanner optics and a hold-down tool, which performs several tasks simultaneously. On one hand, it creates the programmable force-fit



Downholder-tool before pressing down the top contact

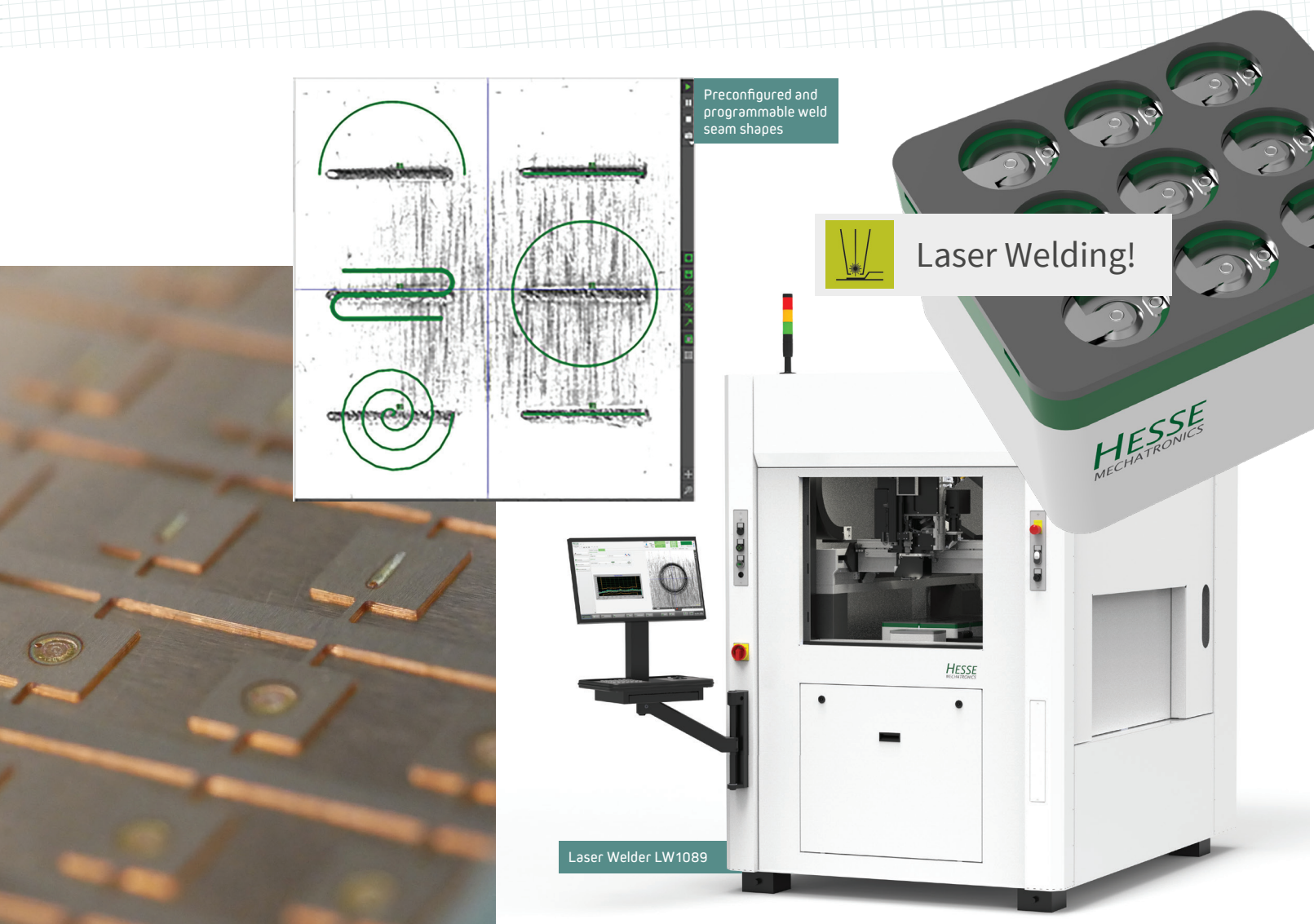
connection between the joining partners, and on the other, it ensures the necessary atmosphere during welding through flow channels. The micro-atmosphere must be as free as possible from ejections and particles, which cannot be entirely avoided in laser welding processes but can seriously interfere with the laser beam path and contaminate the surrounding area. Additionally, the integrated hold-down tool can locally ensure the presence of the process gas (e.g., argon, nitrogen, or a similar inert gas). In this setup, the laser beam is directed at each welding point in a constant vertical position and shielded by the tool's walls.

Another advantage of this setup is its flexibility compared



Dualhead laser cell with LW2095





to other products or product variants. If compatible with the machine's working area, loading a corresponding process program automatically is sufficient; a different protective mask or scanner optics are not necessary.

Seamless integration

A laser welding system that follows this concept can be integrated into manufacturing processes as a standard system. Standardization occurs in terms of working area and/or laser power classes. Depending on the application, for example, typical automotive battery modules with hundreds of 4680-sized cells and large external dimensions, a corresponding system with a larger installation space can

be selected, which can be expanded by adding another head for higher throughput. For these scales, it is particularly beneficial to use the easy integration capability via established standard interfaces, for example, to form a collaborative unit with a robot for positioning the cell contact system via an OPC-UA interface. By enclosing the system in a laser protection cabin, scalable production cells can be created.

Smaller laser welding systems of this concept are designed as closed standard machines providing the necessary safety technology without limiting automation options. Operator interventions are minimized to such an extent that routine tasks (such as calibration or tool changes) can be carried out

remotely or unattended. This still applies if the system is initially planned for use in a laboratory or small series environment.

Tailor-made process

A standard software package granting access to the scanner optics and control of the laser source is common across different system sizes. In addition to guided operator routines and the integration of cameras in the interior, it offers individually parameterizable weld seam shapes for each welding point and/or surface, so that any type of product can be processed within its technical limits. The hardware adjustments are then limited to the replaceable hold-down welding tools and to a configuration

determined in advance of the project, e.g., the laser source, the laser evaluation unit, or the product clamping device.

This type of highly standardized setup combined with individual cell welding forms the latest generation of laser welding systems, leading to a significant improvement in repeatability and quality, especially for cell contacts and contacts for power electronics. Full automation shortens preparatory planning and setup times, and largely eliminates manual processes, which in turn increases efficiency and minimizes the risk of human error. These two factors have always been the focus of every production optimization, not just in battery module production. 
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