

Laser welding examination with the Workswell ThermoInspector system

Laser welding of plastics is a modern technology used to create unbreakable joints in materials. It is a form of welding using heat through the interaction of a laser beam with the welded material and the pressure, which is exerted by the down-pressure force on the welded parts. Compared with traditional technology used for welding plastics, it has several advantages including the absence of additional material, low operating costs and the high efficiency of the process.

As a major advantage of this method is easier automation, it comes as no surprise that this method is regularly used in series industrial sectors. Together with its expansion, there was an increased need to check the quality of weld and the welding itself. For this reason, series companies, particularly from the area of automotive industry, have successfully used the thermo-camera system developed by the Czech company Workswell.

Company presentation

Workswell is a Central European business and manufacturing company with its headquarters in Prague, the heart of the European Union. The company's primary activity includes the delivery of solutions in the area of the contactless temperature measurement. Customers of Workswell include, in addition to the car makers BMW, Škoda, Renault

and Kia, companies such as ČEZ, RWE, Bosch, Honeywell, Tesco, Heineken, Kofola, IKEA, Net4Gas, Semikron, ArcelorMittal and hundreds of various small, medium and large industrial enterprises. Regular clients include prestigious foreign universities.

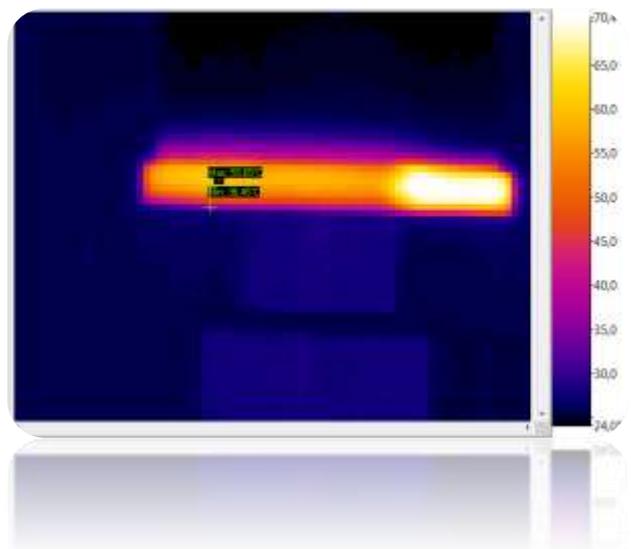
Laser welding

The industrial use of laser welding of thermal plastics is frequently used for the arrangement of welded components whereby one thermoplastic is penetrating after the radiation of the laser and the second thermoplastic significantly absorbs the laser beam. The size of the absorption of the laser beam by the thermoplastics can be modified.

In the case of the 'penetrating' arrangement, the thermoplastics are linked with the different absorbing properties placed one above the other. The laser beam is focused into the gap between the joined components and in the place of the gap is absorbed through the surface into the lower part with the heat required for melting. By sharing the heat, the surface layer of the transparent material is belted from the lower part and while affecting the down-pressure force, both components are welded.

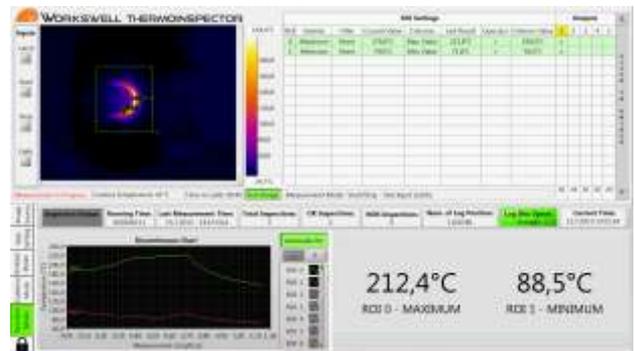
The welding regime is determined by how the laser beam heats welded components. It is possible to select:

- contour mode – when the beam repeatedly creates the trajectory of the contours of the future weld
- quasi-simultaneous mode - when the laser beam is routed to the welding spot with fast-moving mirrors
- simultaneous mode - multiple diodes are used and the area is heated all at once



Laser welding control with the ThermoInspector system

The Workswell ThermoInspector is an inspection system for monitoring, analysing and evaluating the welding of plastics and metals, input-output inspection, quality, thermal and other testing during the whole manufacturing process. It is able to measure continuously and to evaluate the thermal field on the surface of the measured item and to check consequently its thermal characteristics, the course of the maximum and minimum temperatures, to evaluate the dispersion of the temperature along the thermal cut, to check the speed of the increase of temperature in the selected areas and many other statistic indexes that are essential during series production. The system contains a thermal camera, an evaluating control unit and a touch panel for the visualization of inspection outputs. Due to the input - output card, the inspection results can be connected to the control system or PLC.



User interface of the Workswell ThermoInspector system

The principle of evaluating temperatures on the weld

Laser welding requires a special approach concerning the temperature, as well as its evaluation. It is not possible to evaluate the weld only on the basis of the measured temperature by the fact that only the limit temperatures are stated and required. In this case, the user faces the risk that many products will be excluded unnecessarily or many errors will be omitted.

On the basis of our extensive experience with the measurement of temperatures during welding, the ThermoInspector evaluates the quality of weld using three methods:

- 1) two-phase evaluation - each pixel from the area of interest is evaluated (along the weld) and the time curve of the increase of temperature is analysed during the welding along with the time curve of the decrease of temperature after welding. This series of curves is compared with the standard and according to set limits, the welding is evaluated if it was done correctly
- 2) envelope experimental method – using a thermal analysis of a series of up to ten “perfect” welding processes, the so-called envelope of correct values is stated, i.e. the time courses of the temperatures of welding on these good pieces that will be created by the maximum and minimum temperature ranges within which the temperature must vary between these ranges. If this does not happen during the manufacturing and the temperature “outside the “envelope” is detected, the product is detected as defective
- 3) fast point measurement – the region of interest (ROI) is divided into a matrix of individual pixels or groups of pixels and during testing, it is measured how many pixels may have higher or lower temperature than the stated range. If the product does not fulfil this criterion, it is excluded defective

As can be seen from the individual evaluating procedures, before the application of a thermal imaging system into actual operation, it is assumed that tests were run determining which temperatures are acceptable. The result contains information about the conformity with the standard.

Extensive experience with the Workswell ThermoInspector system when measuring temperatures during laser welding shows that it is not possible to exactly determine which is a quality and non-quality weld solely on the basis of single measured temperatures (or the thermal profile). The temperature limits must be stated by measuring the experimental sample of the product. The ThermoInspector is prepared for this necessary step. For integrators, either from the company Workswell or from their partners, it is possible to implement within a matter of minutes into the manufacturing line, to collect the data required for the statistical evaluation of temperatures during manufacturing, to select a suitable evaluation method and to state the temperature limits. These testing measurements are an integral part of the offer for the whole system, without which it would not be possible to ensure reliable inspection and problem-free operation in a 24/7 regime.

The ThermoInspector system is successfully used when inspecting welding in companies producing components for the automotive industry (for example: Pierburg, TRW automotive, FTE automotive). Based on the fact of a fast and exact analysis of temperatures (for measurement as well as complex statistical processing), these companies can easily determine erroneously produced pieces and can immediately exclude them from distribution. In this way, they significantly reduce reclaim costs and resolve problems in production.

