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Management of laser welding based on analysis informative signals

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Abstract. Features of formation precision weld of metal were presented. It has been shown that the quality of the welding process depends not only on the energy characteristics of the laser processing facility, the temperature of the surface layer, but also on the accuracy of positioning laser focus relative to seam and the workpiece surface. So the laser focus positioning accuracy is an estimate of the quality of the welding process. This approach allows to build a system automated control of the laser technological complex with the stabilization of the setpoint accuracy of of positioning of the laser beam relative to the workpiece surface.

1. Introduction

The most promising method of welding is laser welding. Laser welding is carried out by local melting and subsequent crystallisation of metals at their butt surfaces, resulting in strong adhesion occurs at interatomic interactions of welded parts [1].

Automation of the process of laser welding parts in mechanical improve efficiency of technological process (TP). The most expedient is to provide an automatic control system (ACS) Laser technological complexes (LTC) with the stabilization and optimization of energy and time characteristics to obtain the required output parameters TP [2].

2. Development of automatic control system

The structure of information support of ACS include models of individual dynamic modules, as well as models of acting on the signal and noise. This requires adequate mathematical models of TP on the basis of experimental data. However, due to the complexity of the physical processes occurring in laser welding of metals, they do not give a complete picture of events taking place in the area of laser radiation (LR) to the metal [3, 7].

According to the results of experimental research on welding of different metals are widely spread metrics TP quality (the roughness of the weld, the lack of fusions, burning and shells, etc.).

The photographs (see. Fig. 1, 2, 3) are seen strongly pronounced weld defects for steel with given parameters of pulse LR. Fig. 1 seen along the length of the uneven roughness. Fig. 2 shows the burning metal. These results are obtained welding by continuous LR without stabilization LTC settings. When welding with pulse LR (Fig. 3) appeared sealing rings, leading to unevenness in depth microhardness.

Figure 1. Photo of weld by continuously LR without stabilization LTC settings.

Figure 2. Fig. 2. Photo of incision a weld by continuous LR without stabilization LTC settings with burning metal.

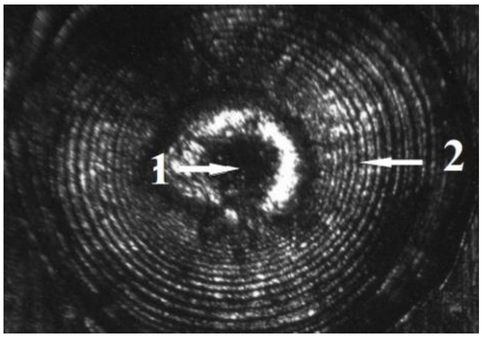

Figure 3. Photo steel surface after exposure to pulsed LR. 1 - impact zone (Φ 0.5 mm, energy LR - 12 J, pulse duration of 3 ms.). 2 - sealing ring.

This is explained by the instability of LTC settings, and the variation of the surface layer of welded metal.

Positioning accuracy LR with respect to joint is the main parameter that characterizes the quality of the welding. For fast-flowing laser welding process is necessary to provide automated management LTC with feedback in parameters measured in real time the progress of TP [4].

The experimental setup was developed, a block diagram of which is shown in Fig. 4.

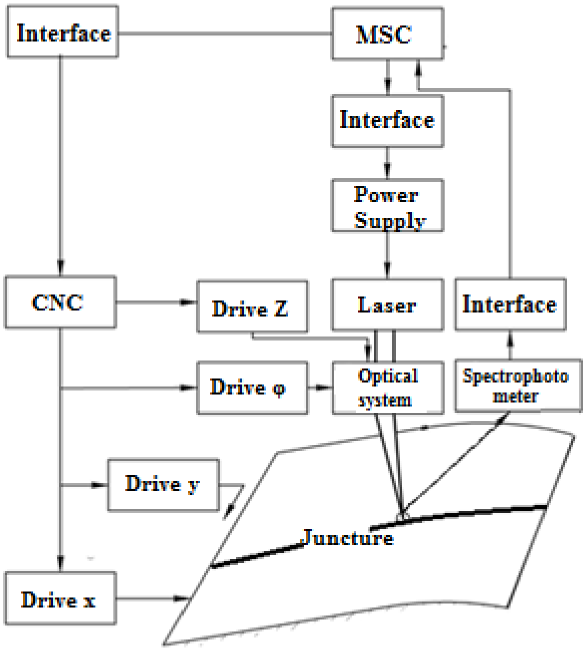

Figure 4. Block diagram LTC

Management parameters of LTC and their stabilization by due to negative feedback on the measured parameters of the zone interaction of LR with the metal. This is achieved by analyzing the position of LR focus with respect to weld and LR angle to a normal plane surface of the workpiece [5]. Structure ACS LTC is a system which is characterized by a large number of feedbacks and is nonlinear.

Certain assumptions allow linearize their transfer functions have been taken in justifying the choice of the mathematical model of the links. Calculations and studies of the properties of ACS made for the linearized system. The analysis in the field of development of ACS research shows the effectiveness of multiple-relay systems with feedback by informative parameters measured in real-time to control the LTC. The analysis was conducted by ACS developed models in MathCAD. The transfer function of the open-loop system has the form [6]:

$$W_r = \frac{K}{(T_1 \cdot p + 1) \cdot (T_2^2 \cdot p^2 + 2 \cdot T_2 \cdot \varsigma \cdot p + 1) \cdot (T_3 \cdot p + 1) \cdot (T_4 \cdot p + 1)} \tag{1}$$

where $K = \prod K_i = 0{,}0005$.

The main element of the spectrophotometer is much area line of photodetectors (Fig. 5).

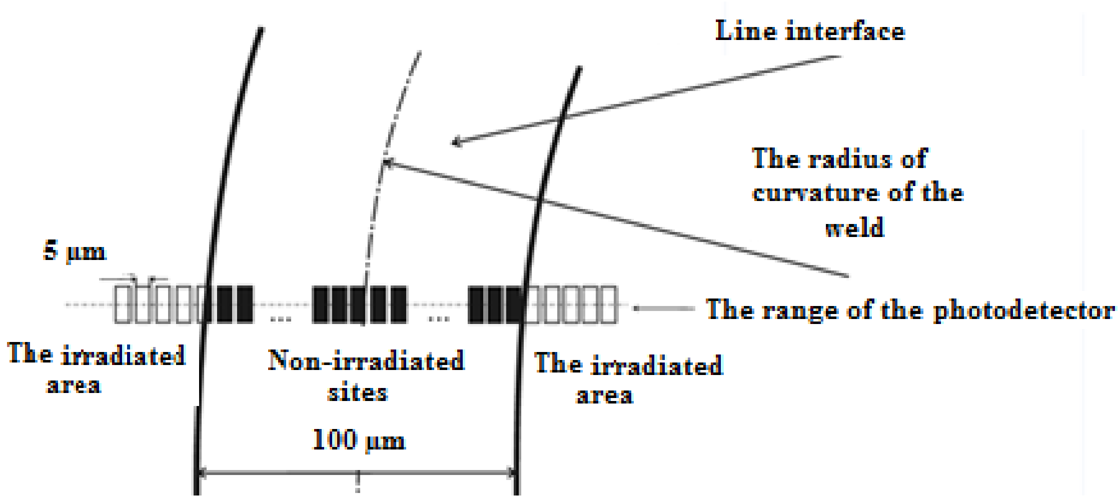

Figure 5. Position much area line of photodetectors with respect to the weld on a curved surface of the part to be welded elements

Technological process of metals welding is provided by a careful fitting edges across the seam length (less than 100 microns) and high positioning accuracy LR. Protection joint surface from oxidation is carried out with a mixture of helium and argon fed through a special nozzle.

3. Conclusion

Experimental research effects of LR to the metals shown possibility of optimizing the energy parameters LTC for welding with obtain the desired quality metrics, which leads to lower energy consumption. Developed ACS LTC satisfies the requirements on positioning accuracy of LR with respect to seam and provide stable welding quality indicators. Locality of the welding zone ensures the rational design of welded components and minimizes the residual deformation.

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