Technology of overlay laser welding of durable powdery into blade edge of miller

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Abstract. In this paper the laser welding technology features of wear-resistant powders on the hob’s cutting edge with laser radiation (LR) focus positioning control are described. It is shown that the quality of the welding process depends on the processing regimes, the energy characteristics of the laser technological complex (LTC), the positioning accuracy of the LR focus and its perpendicularity relative to the plane of a router bit. In this paper we deal with the questions of stabilization of LTC parameters and LR positioning as well.

1. Introduction
The quality of the tool determines the efficiency of production, the competitiveness of its products.

One of the methods of increasing the tool resistance of the, its most important characteristic, is the use of highly concentrated energy sources. The restoration of the tool is possible due to laser surfacing. Automation of the process of laser surfacing of parts in mechanical engineering makes it possible to increase the efficiency of the technological process of tool recovery, with its specified quality indicators [1-3].

Laser surfacing of wear-resistant powders makes it possible to restore the cutting edge of the tool with increased durability. The wear of the tool edge is a consequence of a change in operating conditions, which is characterized by an increase in cutting and cutting forces at high temperatures.

The purpose of the study is to analyze methods and experiments to improve the quality of TP, using the results of the experimental work on the restoration of the tooth milling tool steel R18K5F2 with increased durability.

In this paper, the task is to perform laser surfacing of the tooth milling cutters and microstructural studies.

2. Experimental research
The influence of the instability of LTC parameters, the optical-physical properties of the surface and the positioning of the focus of laser radiation (LR), relative to the edge of the milling cutter, lead to a decrease in the quality of surfacing [4-6].

To stabilize them, ACS LTK with negative feedbacks was developed for the parameters of surfacing (LR energy density, temperature, and positioning accuracy of the focus) [5].

The process LR interaction with metal during surfacing is characterized by the formation of a plasma torch (Figure 1.), which shields the interaction zone, which does not allow us to use optical-
physical methods for studying the thermal-effect zone. However, the use of pulsed LI enhances these capabilities.

Figure 1. Conditional image of interaction process between LR and metal

The research involved laser surfacing of the BoroTec-Eutalloy® 10009 powder for steel R18K5F2 using flux grade AN-43. A number of changes in the structure of the metal and phase transformations that occurred during heating and subsequent cooling occurred during heat treatment characterized by the type of thermal cycle. The initial heating of a certain volume element to a temperature $T_c$ followed by rapid cooling to a temperature below $T_c$ is necessary for the welding process of steel (according to the Chernov diagram) [7]. This process takes place when the melting point in the zone of processing the temperature of the powder and metal is reached [3, 6]. Restoration of the hob’s router bits and the preparation of other structures takes place on condition that the quality of the surface deteriorates. Figure 2 shows a fragment of the tooth of a worm cutter with a defect in the leading edge.

Figure 3 shows the worm hob with a thermal contour of LR. The weld layer has a thickness of less than 0.1 mm, with a depth of thermal influence of about 0.4 mm. The microhardness at the surface is $HV_{0.05}$ 585 and reaches a value of $HV_{0.05}$ 769 at a distance of 0.1 mm from the surface.

The deposited layer consisting of BoroTec-Eutalloy® 10009 powder and flux is clearly distinguishable. Optimum content of alloying elements, silicon and manganese, as well as limiting the content of phosphorus and sulfur in the deposited metal layer is ensured by the use of flux grade AN-43.

Figure 2. Fragment of a hob’s router bit with a leading edge defect

Figure 3. Fragment of a hob’s router bit with surfacing of Ni-Cr-B-Si-Fe powder, BoroTec - Eutalloy® 10009
Modeling of the hob cutter’s surface is necessary for controlling the parameters of the LTC optical system and the size of the flanking [2.6].

![Microhardness measurement results](image)

**Figure 4.** Measurement results of microhardness and microstructure of a worm hob obtained with an increase of x 200

The microstructure of the part (Figure 4) is a hidden-needle martensite and carbides. The carbide heterogeneity in the structure of the milling cutter corresponds to 1A on a scale of 1, which satisfies GOST 19265-73 [8].

In the microstructural investigation, a surface hardened layer with a non-structuring structure and carbides was found on the surface of the working edge of the teeth of the milling cutter. The high hardness of the hardened layer (up to HV0.1 970) has a positive effect on the wear resistance of the mill, which manifests itself at a high temperature of the tool edge.

### 3. Conclusion.

The physicochemical properties of the materials of a tool, a powder, a flux, and the process medium affect the laser welding process of high-strength coatings having increased wear resistance. Various chemical activity and thermophysical properties leading to a different distribution of the thermal field are main reasons for this phenomena [9]. The specific energy input of the energy source and all types of interaction between the medium and the metal characterize the temperature dependence for the sputtering zone and surfacing. The optimal values and stability of the parameters depending on the physical and chemical properties and temperature of the environment affect the quality of the surfacing process.

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