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## Laser welding with deep alloying of the elements of the truck chassis

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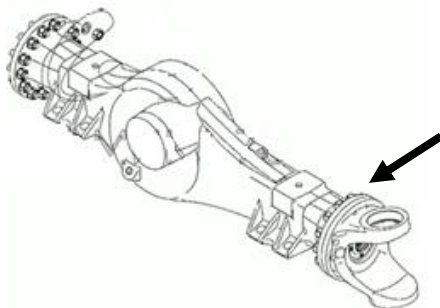
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**Abstract.** A method of laser welding with simultaneous alloying of 2.4060 over the entire depth of the melt bath for connecting the crankcase and the steering knuckle of a truck chassis is described. The results of experimental studies of the macro and microstructure of various zones of laser welding of 35HGSA steel with steel 1.0570 are presented. A comparative analysis of the hardness of the melt zone and the heat affected zones for samples with and without alloying is carried out.

### 1. Introduction

At present, to connect the crankcase (1.0570 steel) and the knuckle (35HGSA steel) of the truck chassis, bolt fastening of the flanges of the parts is used (figure 1).



**Figure 1.** The classic version of the fist with the crankcase. The arrow shows the junction.

The bolted connection is not reliable, it requires a lot of labor and constant maintenance in operation. The flanges of the parts that protrude beyond the mounting dimensions limit the spatial movement of the wheels of the vehicle. At the same time, laser welding is widely used in the automotive industry [1-4].

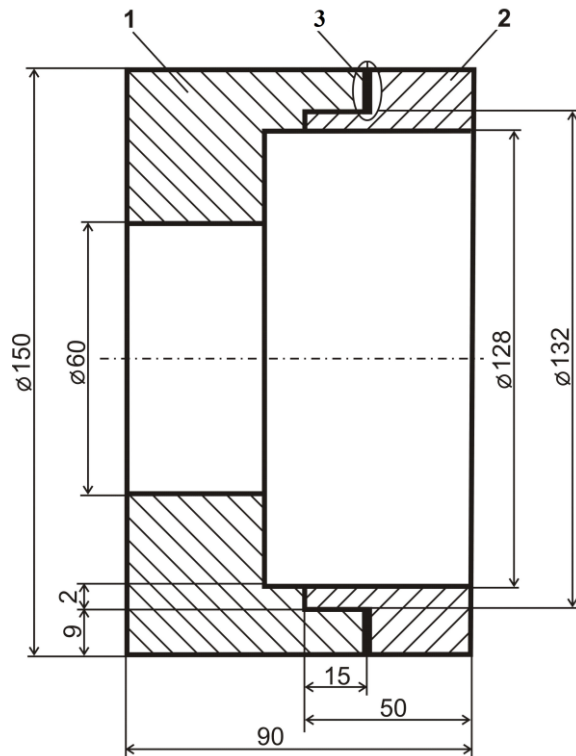
Melt alloying is used for welding dissimilar steels [5-7, 10, 11]. In [8, 9], the condition for obtaining high-quality laser welding of parts of large thicknesses is described.

The present paper presents a method for laser welding of parts of dissimilar steels with a thickness of 10 mm. To improve weldability and ensure the strength characteristics of the compound, 2.4060 alloy component is introduced into the melt pool.



## 2. Research methods

Experimental laser welding with simultaneous alloying of the molten bath was carried out on cylindrical samples of 1.0570 steel, used for the manufacture of the crankcase and limited to 35HGSA welded steel, used for the manufacture of the knuckle (figure 2). 2.4060 alloying material insert is installed between the parts to be welded over the entire contact area.



**Figure 2.** Design sketch for laser welding. 1 - 35HGSA steel, 2 - 1.0570 steel, 3 - alloying insert.

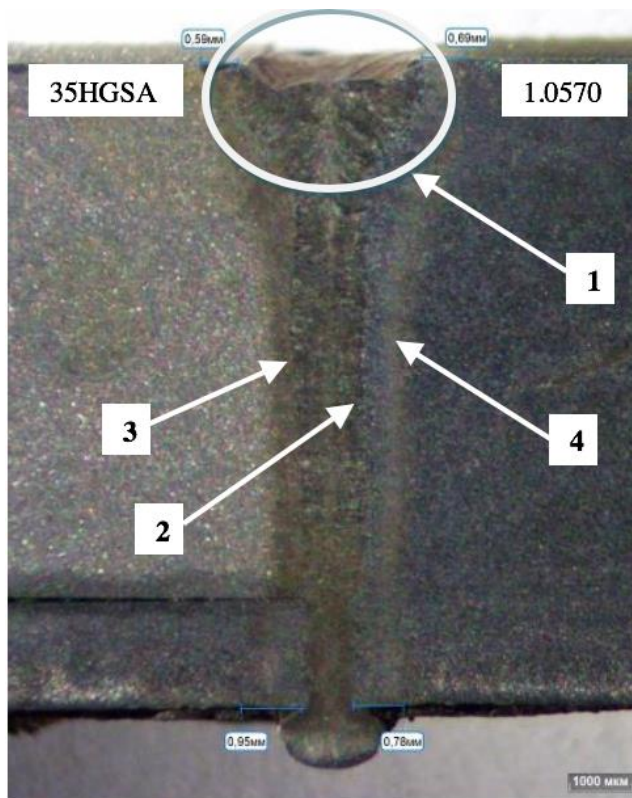
5 kW cw YLS-5000-SM laser was used as a heating source. Welding speed was 1 m/min. Welding was carried out in an argon medium. 2.4060 alloying component is a tape of 0.2 mm thick.

The study of the structure of welded joints was carried out on STEMI 2000-C microscope with the option of assessing the quality of the structure of Thixomet Pro materials. Microhardness was measured with HVS-1000 microhardness tester.

Deep welding experiments were carried out on two groups of samples: I - 35HGSA steel with 1.0570 steel without alloying additive; II - 35HGSA steel with 1.0570 steel with 2.4060 alloying additive.

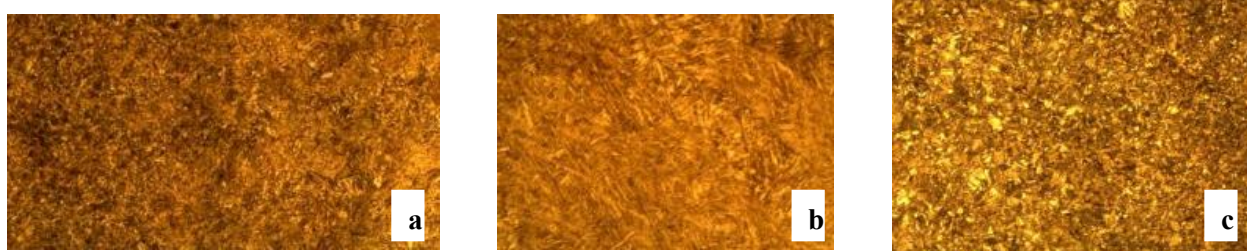
## 3. Results and discussion

The appearance of the macrostructure of the cross section of the welded joint of steels of group I is shown in figure 3.



**Figure 3.** The macrostructure of the cross section of the welded joint of steels of group II: 1 - the zone of the primary bath of the melt, 2 - the zone of the melt, 3 - the zone of thermal influence from 35HGSA steel, 4 - the zone of thermal influence from 1.0570, x10 steel.

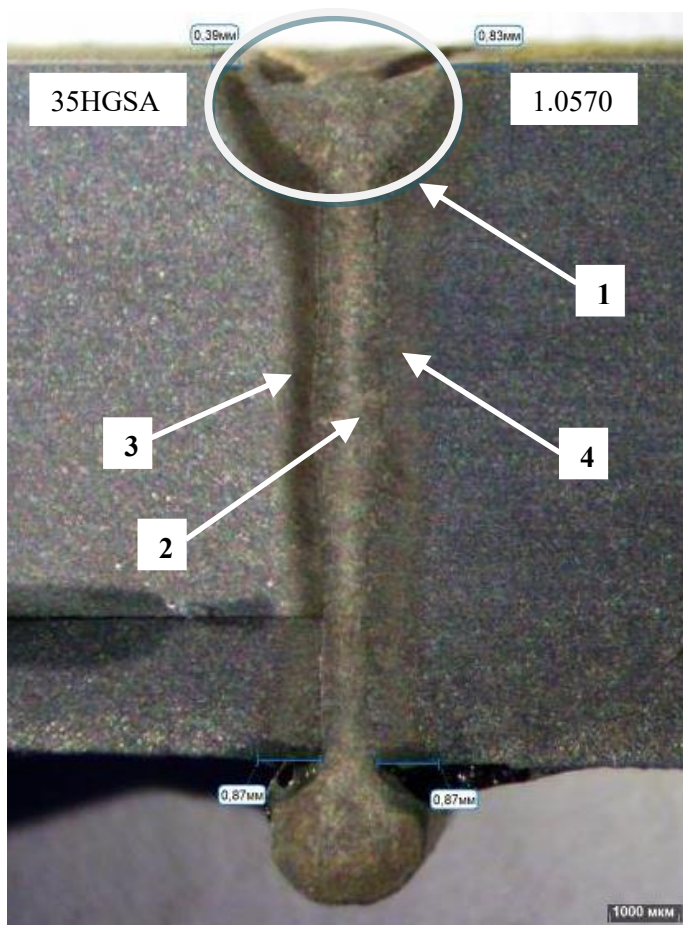
The structure is a “dagger penetration” characteristic of continuous laser irradiation. The melt depth is 10 mm, the melt width is 1 mm, the width of the heat affected zone is 3 mm. In the upper part of the melt from the irradiation side, a primary cone-shaped melt bath with dimensions of 2.6 mm x 2.0 mm is clearly visible. The structure of the weld is dense, uniform without sharp boundaries of phase transitions, without visible defects. The microstructure of the welded joint of the sample of steels of group I is shown in figures 4-6.



**Figure 4.** Microstructure of the cross section of the welded joint of group I: a - zone 3, b - zone 2, c - zone 4, x500

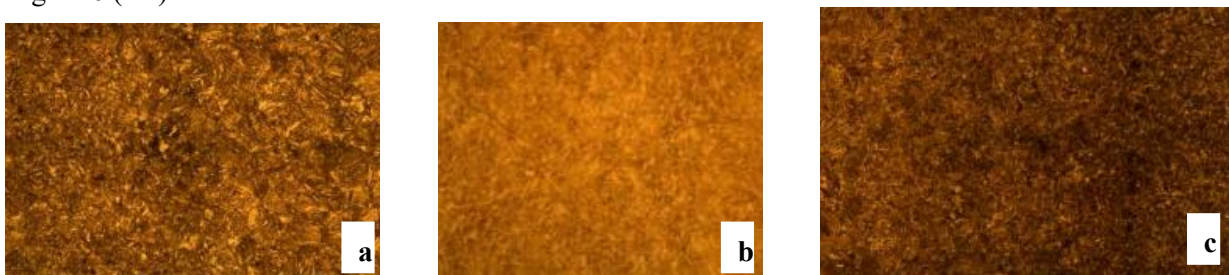
The melt zone 2 of the welded joint of the group of steels I is needle martensite with an average hardness of  $514 \pm 40$  HV1. The heat affected zone of 3 steel groups I is a combination of Troostite  $\rightarrow$  Sorbitol with an average hardness of  $261 \pm 40$  HV1. The heat affected zone of 4 steel groups I is a combination of Troostite  $\rightarrow$  Sorbitol with an average hardness of  $333 \pm 40$  HV1.

The appearance of the macrostructure of the cross section of the welded joint of group II steels is shown in figure 5.



**Figure 5.** The macrostructure of the cross section of the welded joint of steels of group II: 1 - the zone of the primary bath of the melt, 2 - the zone of the melt, 3 - the zone of thermal influence from 35HGSA steel, 4 - the zone of thermal influence from 1.0570, x10 steel.

The presented structure practically does not differ in appearance from the macrostructure for the group I of steels. The microstructure of the welded joint of the sample of steels of group II is shown in figure 6 (a-c).



**Figure 6.** The microstructure of the cross section of the welded joint of group II: a - zone 3, b - zone 2, c - zone 4, x500.

Melt zone 2 of the welded joint of steel group II is martensite with an average hardness of  $439 \pm 40$  HV1. The heat-affected zone of 3 steel groups II is a combination of Martensite  $\rightarrow$  Troostite  $\rightarrow$  Sorbitol with an average hardness of  $582 \pm 40$  HV1. The heat-affected zone of 4 steel groups II is a combination of Martensite  $\rightarrow$  Troostite  $\rightarrow$  Sorbitol with an average hardness of  $430 \pm 40$  HV1.

A comparative analysis of the hardness in the corresponding zones for groups I and II of steels showed that the introduction of 2.4060 alloying component into the molten bath leads to the

appearance of more plastic and less solid structural formations in the melt. These structural - phase changes have a positive effect on the strength properties of the weld under cyclic alternating loads characteristic of the operation of the truck chassis. In the heat affected zones of groups 3 and 4 of steels II, the hardness rises two and a half times for 35HGSA steel and one and a half times for 1.0570 steel. It is likely that the presence of 2.4060 dopant in the molten bath stimulates the saturation of the heat-affected zone with carbon due to redistribution from the base material. However, carbon depletion of the base material in the abutment areas in the heat affected zone leads to softening and deterioration of the strength properties of the welded structure. It can be assumed that the transition zone from the base material 1.0570 to the heat-affected zone 4 will be a possible zone of destruction of the welded structure of the crankcase and steering knuckle under alternating cyclic loads during field tests of the chassis.

#### 4. Conclusion

The introduction of a welded joint of 35HGSA steel and 1.0570 steel of an additional 2.4060 alloying component into the melt pool has a positive effect on the structural-phase composition and weldability of dissimilar steels.

In the course of further work, in order to confirm the conclusions obtained in this work, destructive testing of laboratory samples for tensile, bending, and impact strength at various temperature conditions will be carried out.

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