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- ✓ Strength of materials and structural elements;
- ✓ Mechanical technologies;
- ✓ Dynamics of mechanical systems.

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Content

increases the strength and wear resistance of laser-treated metal parts made of high-quality structural carbon steel 1.1151 without loss of ductility.

During the use of standard processing methods, we will get harder and more brittle hardening structures of martensite or bainite, which will adversely affect the material under tensile or bending loads.

Based on the obtained results, it can be stated that laser treatment for high-quality structural carbon steel 1.1151 with a carbon content less than 0.3% is significantly better to standard, long-known processing methods (for example, heat treatment, hardening).

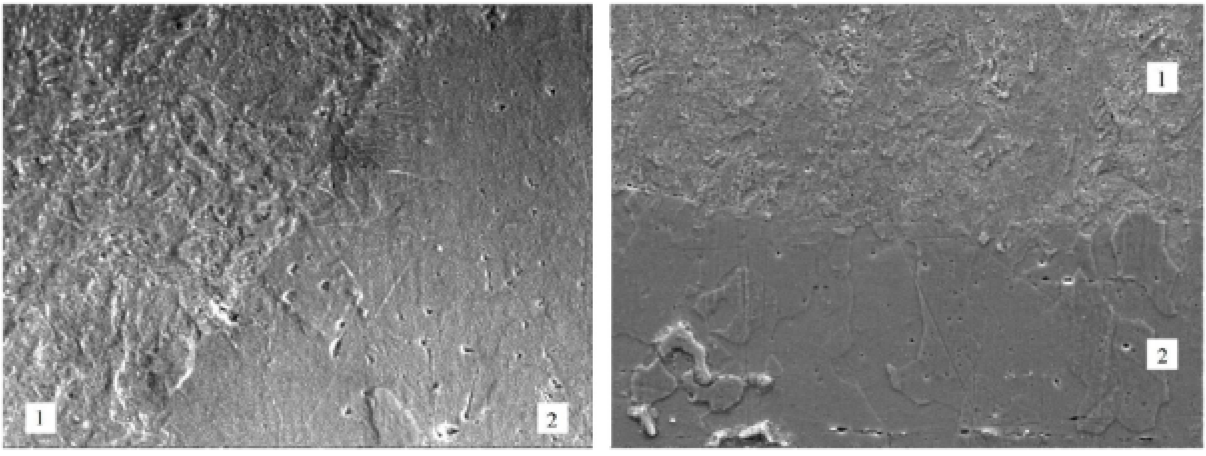

Fig. 2 Microstructure: a – magnification x3000, b – magnification x1000, 1 laser treated zone, 2 untreated zone.

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Keywords: reinforcing ribs, laser treatment, microstructure.

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Investigation of the Microstructure of Reinforced Ribs Created by Laser Treatment

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1. Introduction

With over 3,500 different grades and almost 2 billion tons of steel produced worldwide each year, steel is the most commonly used metal in the world. Given the number of different elements and the different qualities of those elements added to create steel alloys, there are many different types of steel [1]. One of the modern and popular steel processing methods is – laser treatment.

Laser processing can locally generate phase transformations in metals. This treatment changes the structure and properties of materials, for example, increases rigidity [2].

The aim of the study was to evaluate how the microstructure of thin sheet steel changes under the laser treatment.

2. Object of the research

High-quality structural carbon steel 1.1151 after producing laser treatment (Fig. 1.) with a carbon content of less than 0.3 % and chemical composition which presented in Table 1 was used in the experiment.

The smallest changes in carbon content can significantly affect all properties of steel. These steel grades have high ductility and deformability [3].

Fig. 1 Cross-section view of a reinforced ribs

Table 1

Chemical composition % of steel 1.1151

	C	Si	Mn	P	S	Cr+Mo+Ni
Chemical composition according to standard [3]	0.17 - 0.24	max 0.4	0.4 - 0.7	max 0.03	max 0.03	max 0.63
Chemical composition of sample after leaser treatment	0.17	0.13	0.44	0.02	0.02	0.12

3. Research methodology

Properties of material and laser processed area was determined:

- chemical composition - by spectral analysis using the PMI Master PRO Oxford Instruments (UK) according to EN 10083-2:2006 [4];

- hardness was measured according to EN ISO 4516 [5] by Zwick/Roell ZHU universal hardness tester, using the Vickers method with a square-based tetrahedral pyramid;

- macroscopic and microscopic examination was done according to ISO 17639:2003.

Metallographic analysis was carried out by using a:

- Nikon Eclipse MA200 optical microscope (Japan) with Lumenera Infinity 2-2 video camera;

- JEOL JSM-7600 (Japan) scanning microscope, equipped with an energy-dispersive spectrometer (EDS) Oxford INCA Energy X-Max20 (UK).

Etchants for macroscopic and microscopic examination were selected according to ISO/TR 16060:2003. A Nital solution (3 wt.% concentrated nitric acid in ethyl alcohol) was used for etching the steel samples.

4. Results

Macroscopic and microscopic analysis showed (Fig. 2):

- low-carbon ferritic-pearlitic steel after laser treatment acquired the structure of sorbite: a ferrite-cementite mixture, where cementite has a rounded shape and hardness;

- distance between lamellae in laser treated zone was about 0.4 micrometers with grain size G11.

No rigid or breakable quench structures, as well as other unwanted inclusions or internal defects in the laser treated zone were observed.

Microhardness study showed that the hardness of the metal can be increased from 140 HV up to 208 HV based on the provided laser treatment when compared treated zones to the untreated zones.

5. Conclusions

The pearlite structure that is presented in the untreated zones has a large texture compared to the finer texture of sorbit that is obtained after laser treatment.

Structure of sorbit has much more advantages in this case, since it has a higher dispersion and rigidity, which